DEL MEDICAL

Direct Ray
EPEX Omniflex IV System
Service Manual

EPEX Omniflex IV

P/N 8000-EPEXOMNISM

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CAUTION

Federal (USA) Law restricts this device to sale by or on the order of a physician (or properly licensed practitioner).

Attention: Consult Accompanying Documents - As Applicable

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About This Manual

This manual contains service information for the Del EPEX/Omniflex IV System. It includes an overall description of how the system operates and provides detailed service support procedures such as repair and replace, troubleshooting, validation, and calibration.

This manual is intended to service the EPEX/Omniflex IV System consisting of the following components:

- DirectRay Detector and DirectRay Controller
- Overhead Tube Crane
- DirectRay Console
- X-ray Generator
- Radiographic Table

Intended Use

The EPEX/Omniflex IV System is an assembly of components for the controlled production of diagnostic images with X-rays. It includes the X-ray Generator, the DirectRay Console, the Collimator as the beam limiting device, and the DirectRay Detector as the image receptor. Digital images can then be viewed, stored, or printed. The system provides a digital image capture capability for conventional radiographic examinations (excluding fluoroscopy, angiography, and mammography). The system then transmits image data for hardcopy, soft display, or storage via Ethernet using the Digital Imaging and Communication in Medicine (DICOM) 3.0 protocol.

Audience

This manual is intended for service engineers who have fulfilled the following training prerequisites or have equivalent experience:

- EPEX/Omniflex IV System
- Radiation safety
- Electronics, including troubleshooting skills
- X-ray theory
- X-ray Generator systems
- X-ray image quality
- Solaris 2.x fundamentals
- System analytical skills
- Network protocol and IP addressing
- Software environments:
  - DOS
  - Windows 95/98 or Windows NT
  - Internet browsing
  - FTP protocols

Organization

Chapter 1: Safety Information

Provides a description of the safety requirements for installing, maintaining, and servicing X-ray equipment.

Chapter 2: General Information

Provides a description of the EPEX/Omniflex IV System components.

Chapter 3: Installing the System Hardware

Provides steps for the installation process.

Chapter 4: Adjustments and Calibration

Provides the steps for adjustments as well as a description of the calibration process.

Chapter 5: Preventive Maintenance

Provides a preventive maintenance schedule and procedures for maintenance of the EPEX/Omniflex IV System.

Chapter 6: Repair and Replacement

Provides information on the location of instructions for the repair and replacement of EPEX/Omniflex IV System components.

Chapter 7: Diagnostics and Troubleshooting

Provides diagnostics and troubleshooting guidelines as well as guidelines for responding to error codes.

Appendix A: Specifications

Provides specifications for the EPEX/Omniflex IV System components.

Appendix B: Recommended Tools

List of tools and equipment required for installation and/or service.

Appendix C: Forms

Provides installation, maintenance, and calibration forms.

Appendix D: Field Replaceable Units

Lists the names and part numbers for the most commonly field-replaced components.

Appendix E: System Wiring Diagrams

Contains EPEX/Omniflex IV System wiring diagrams.

A glossary follows Appendix E.

Conventions Used in This Manual

This manual uses three types of special messages to emphasize information or point out potential risks to personnel or equipment. A sample of each message type follows.

Note: *Notes provide additional information, such as expanded explanations, hints, or reminders.*

CAUTION

Cautions point out procedures that you must follow precisely to avoid damage to equipment, loss of data, or corruption of files in software applications.

WARNING

Warnings point out procedures that you must follow precisely to avoid injury to yourself or others.

Chapter 1
Safety Information

Personnel operating and maintaining the equipment should receive EPEX/Omniflex IV System technical training, and be thoroughly familiar with all aspects of its operation and maintenance. To ensure their safety, all users should read this chapter carefully before using the system. Additionally, to promote safety awareness, Service Engineers should periodically review the basic precautions outlined in this chapter.

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General

The following are general safety precautions:

- Only personnel who have completed a Del training course for EPEX/ Omniflex IV System maintenance are qualified to remove the covers and repair or maintain the equipment.
- Do not defeat or bypass built-in equipment safety features.
- Observe all warnings and cautions, stated or implied, in the procedures.
- Follow all safety labels on the equipment.

Electrical

Only a qualified/trained Del Field Service Engineer or electrician should replace electrical components.

Only properly trained and qualified personnel should be permitted access to the internal parts. Live electrical terminals are deadly; ensure that line disconnect switches are opened and other appropriate precautions are taken before opening access doors, removing enclosure panels, or attaching accessories.

Do not remove high voltage cables from the X-ray tube housing or high tension Generator and/or access covers from the Generator until the main and auxiliary power supplies have been disconnected.

WARNING

Failure to comply with the foregoing may result in serious or fatal injuries to the operator or those in the area.

Mechanical

The following are mechanical safety precautions:

- Keep fingers, hands, and tools clear of moving parts.
- Unless specifically instructed otherwise, do not operate the equipment with covers or access panels removed.
- Route cables properly to eliminate tripping hazards.

Safety Warnings and Cautions

General Use Warnings

WARNING

Federal law restricts this device for sale or use by or on order of a physician or properly licensed practitioner.

WARNING

Only qualified personnel may operate the EPEX/Omniflex IV System equipment. Operation of the equipment by persons who have not been trained or who are unfamiliar with the EPEX/Omniflex IV System's functions and controls may cause serious injury to the patient, serious injury to the operator, or equipment damage.

WARNING

The EPEX/Omniflex IV System includes no user serviceable parts. For service assistance, contact Del.

Field Warnings

WARNING

TheEPEX/Omniflex IV System produces ionizing radiation. Operators must meet all state and local requirements and regulations.

WARNING

The DirectRay Detector may only be operated in an area that is located beyond the 20 gauss limit. Operating the unit within the magnetic fields that are higher than this limit may cause the unit to malfunction, resulting in operator or patient injury.

Electrical and Flammable Warnings

WARNING

The DirectRay Console component of the EPEX/Omniflex IV System may not be located in the patient environment.

WARNING

The EPEX/Omniflex IV System and associated cables must not be operated in the presence of moisture.

WARNING

To avoid excessive product leakage currents and to maintain product compliance to medical protective earthing and grounding requirements, the DirectRay Console's power cord must be connected directly to a hardwired ac mains receptacle. Under no circumstances should the DirectRay Console's power cord be connected to a multiple receptacle extension device that also supplies power to other electrical hardware that is electrically connected to the EPEX/Omniflex IV System.

WARNING

Ensure that earth grounding connections between the components and the building are maintained at all times. The components include: DirectRay Detector; Overhead Tube Crane; Radiographic Table; X-ray Generator; and DirectRay Console.

WARNING

The DirectRay Console cabinet includes a dedicated, bolted, protective ground connection to the building's electrical system. Do not remove the grounding connection for any reason. If it becomes damaged, contact a qualified Service Engineer.

WARNING

The UPS battery must be replaced by an authorized Del representative. The UPS battery contains lead and poses a hazard to the environment and human health if not disposed of properly.

WARNING

The EPEX/Omniflex IV System is not suitable for operation in the presence of a flammable anesthetic mixture with air, oxygen, or nitrous oxide.

Moving and Using Equipment Warnings

WARNING

Use at least two qualified people when moving equipment in order to prevent injury or strain.

WARNING

The equipment is fragile and must be handled with care.

WARNING

Excessive use of the keyboard and mouse or trackball may result in repetitive strain injury.

Cleaning Cautions

CAUTION

Do not spray cleaning solution directly onto the equipment. Instead, moisten a cloth with the solution and wipe the equipment.

CAUTION

Do not immerse the equipment, including any components or accessories, in liquid.

CAUTION

Do not autoclave the equipment, including any components or accessories.

Safety Symbols

The following safety-related symbols are found on the equipment. To avoid injury, learn to recognize them.

Radiation

Power Off (used with the DirectRay Console UPS)

Power On (used with the DirectRay Console UPS)

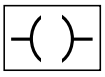
Ethernet Connection

Twisted Pair Ethernet Connection

Explosive Gas (flammable)

Attention—Read the CAUTION or WARNING statement that follows.

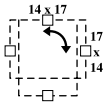
Non- Anesthetic Proof



Universal Interface Connection Identifiers

Sound

Earphones



DirectRay Detector Orientation Identifier (on the Bucky)

Protective Earth Ground

Hazardous Voltage

Power On Indicator

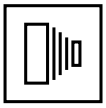
Hard Drive

Standby Switch (used with CPU)

On Line Indicator (used with X-ray Generator switch at DirectRay Console)

Off Line Indicator (used with X-ray Generator switch at DirectRay Console)

Prep/Exposure Switch



X-ray Expose Switch

Do Not Immerse In Liquid

This product contains no field-serviceable parts.

Special Cleaning Instructions

Lifting Warning

One or more of the following regulatory symbols are found on the equipment.

UL Classified Device

UL Listed Device

UL Recognized Device

CSA Listed Device

ETL Listed Device

Safety and Compliance

Exposure to ionizing radiation such as X-rays can be hazardous. United States federal regulations establish appropriate exposure limits so that the patient, the operator, and the general public are not exposed to such radiation unnecessarily. Personnel operating systems such as the EPEX/Omniflex IV must be trained and qualified. They must be familiar with established regulations and understand the risks associated with the operation of a X-ray system. They must know what action to take if and when a hazardous situation arises.

For a more complete understanding of radiological hazards and their control, X-ray system operators are referred to publications, such as:

- Medical X-ray, Electron Beam and Gamma Ray Protection for Energies up to 50 MeV – Equipment Design, Performance and Use (Report No. 102, National Council on Radiation Protection)

- Medical X-Ray Protection up to Three Million Volts (Handbook No. 76, National Bureau of Standards/National Institute for Standards and Technology)

In addition to ionizing radiation, other safety concerns are addressed by various U.S., Canadian, and international standards. The component parts and subsystems used in the EPEX/Omniflex IV System have all been tested for compliance with the safety standards in effect at the time of product release/introduction in the United States (UL 2601-1 or UL 1950), Canada (C22.2 No. 601.1-M90 or C22.2 No. 950-95), and the European Union (EN60601-1, and collateral and particular standards, EN 60825-1, and/or EN60950).

The results of these safety tests and inspections show that the EPEX/Omniflex IV System is safe. There are, however, certain residual hazards resulting from the mechanical articulation of the system. Minimizing the risk of injury to the patient and to the operator resulting from these residual hazards requires care and alertness on the part of the operator.

When appropriate, parts and subsystems have also been tested and evaluated for compliance with electromagnetic compatibility (EMC) requirements, including radio frequency emissions. The CE mark displayed on each part and subsystem indicates compliance with generally accepted EMC requirements as well as with European safety requirements.

Radiation Protection

Serious unfavorable health effects can result from short term exposure to high levels of ionizing radiation (such as X-rays) as well as from long term exposure to low levels. Personnel who operate the EPEX/Omniflex IV System should familiarize themselves with both the short term and the long term effects of radiation exposure and take appropriate measures to minimize the amount of radiation to which they are exposed while performing their duties. Some effects of X-radiation are cumulative, and may extend over a period of months or years. The best safety rule for X-ray operators is to avoid exposure to the primary beam at all times.

Ionizing radiation occurs naturally in the environment. It is generated by astronomical radiation sources such as the sun and the stars, and by the soil under our feet. The atmosphere filters radiation from astronomical sources. As a result, the radiation level from these sources is much lower at sea level than on the summit of high mountains. Radiation generated in the soil varies greatly from place to place depending on the composition of the soil. For example, areas rich in granite rock have a higher level of radiation than other areas.

Any materials placed in the path of the beam absorb natural as well as manmade radiation, such as the X-rays used in the EPEX/Omniflex IV System. Materials with a high atomic number, such as tungsten, lead, and uranium, absorb X-rays much more effectively than materials with a low atomic number such as hydrogen, aluminum, or beryllium. Therefore, lead is used for shielding the radiologist's workstation in most X-ray facilities, including ones using the EPEX/Omniflex IV System. If there are windows in the partition separating the operator from the patient, these windows are typically glazed with lead glass and provide effective protection against ionizing radiation.

To minimize dangerous exposure, use movable lead screens, lead-impregnated gloves, and lead-impregnated aprons. These protective devices must contain 0.25 millimeter thickness of lead or the equivalent. Use such protective devices for all operators, observers, and/or servicing personnel exposed to radiation fields of five or more milli-Roentgens per hour.

The shielding provided for a typical X-ray facility's operator workstation is generally quite effective and reduces the residual radiation from diagnostic X-rays to a level that is comparable to or lower than natural background radiation. If the operator abandons the protected environment of the workstation, he or she may be exposed to a significantly higher level of radiation. For a single exposure this may still not lead to serious health effects, but repeated carelessness in this regard may lead to serious consequences.

Any object in the path of the primary beam produces scattered radiation. In the absence of proper precautions, scattered radiation can result in a substantial radiation dose to the operator or any other personnel in the facility. Moveable screens may be used to shield occupied areas from scattered radiation.

The X-ray Generator in the EPEX/Omniflex IV System only produces X-rays when high voltage is applied to the X-ray tube. When the high voltage is removed X-ray, emission ceases without delay.

Authorized EU Representatives

The manufactures or parts and subsystems in the EPEX-Omniflex Overhead Tube Crane are represented in the European Union by the following:

Villa Sistemi Medicali
Via delle Azalee 3
20090 Buccinasco (MI)
Italy

Identification Labels

The EPEX/Omniflex IV components have manufacturing and certification information affixed. The manufacturing label contains:

- The full name and address of the manufacturer of the component
- The place, month, and year of manufacture
- The model number and serial number of the component

The certification label also states that the component complies with either “21CFR, Subchapter J”, or the applicable DHHS standards under the Radiation Control for Health and Safety Act of 1968 (or its equivalent).

A label may combine both manufacturing and certification information.

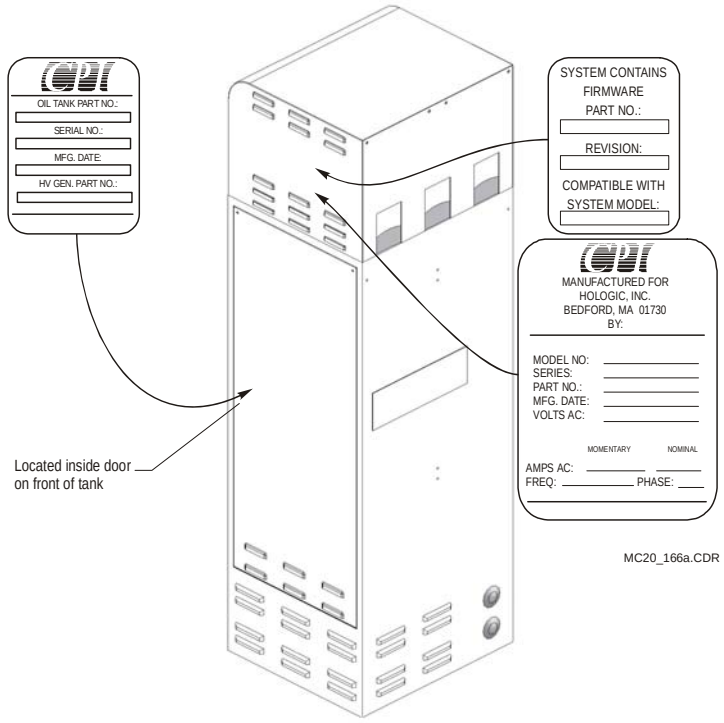
Overhead Tube Crane Labels

Refer to the EPEX/Omniflex IV Overhead Tube Crane service manual for the location of the Overhead Tube Crane Identification labels.

Generator Labels

The location of the Generator identification labels are shown in Figure 1-1.

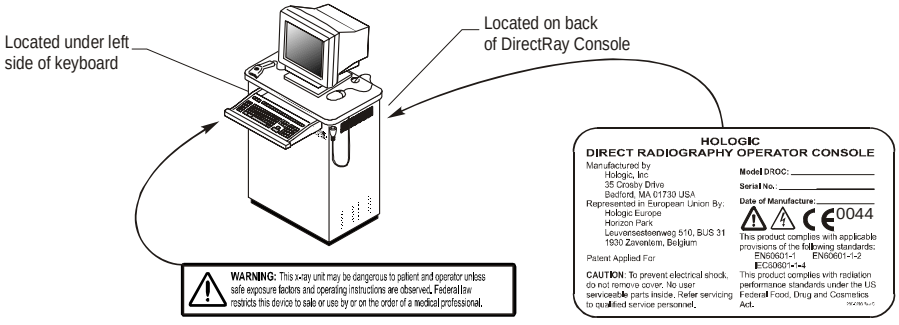
Figure 1-1. Location of the Generator Identification Labels



DirectRay Console Labels

The location of the DirectRay Console Labels are shown in Figure 1-2.

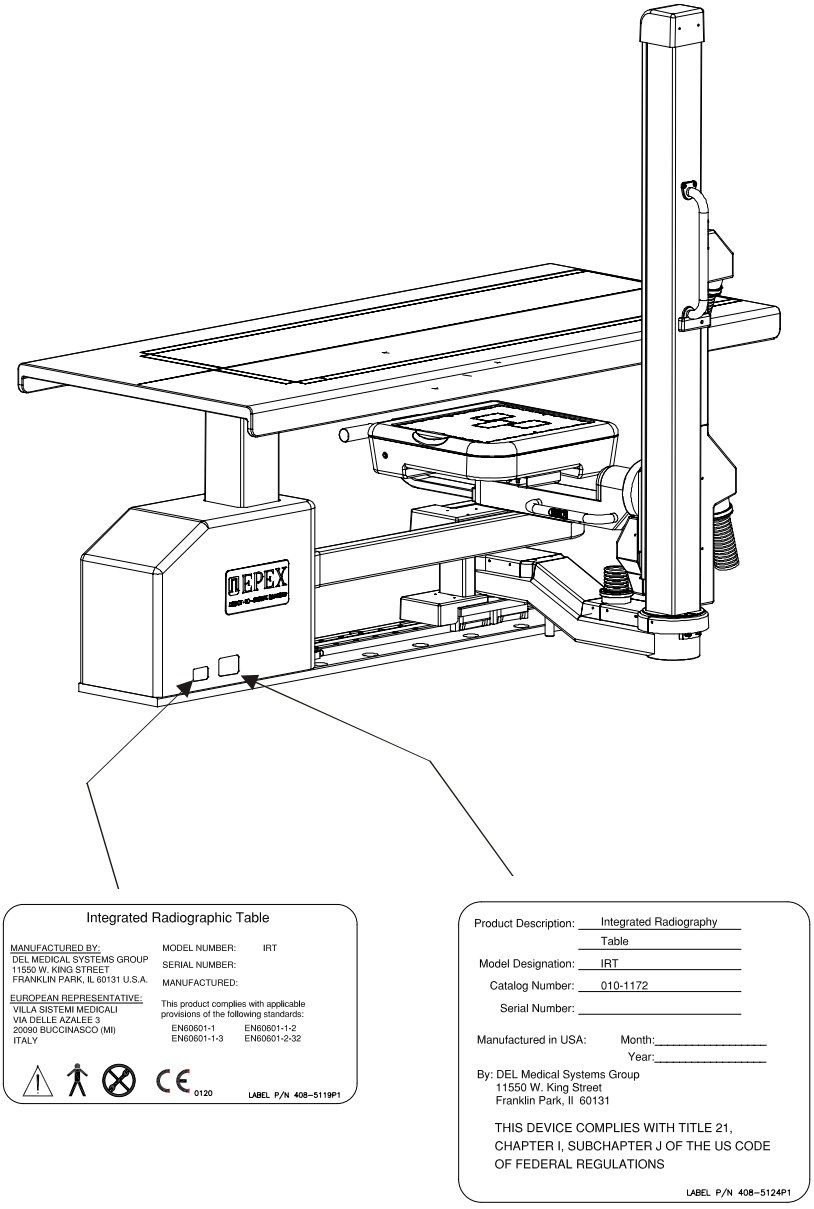
Figure 1-2. Location of the DirectRay Console Identification Labels


Located under left side of keyboard
Located on back of DirectRay Console
WARNING: This x-ray unit may be dangerous to patient and operator unless safe exposure factors and operating instructions are observed. Federal law restricts this device to sale or use by or on the order of a medical professional.
HOLOGIC
DIRECT RADIOGRAPHY OPERATOR CONSOLE
Manufactured by
Hologic, Inc
35 Crosby Drive
Bedford, MA 01730 USA
Represented in European Union By:
Hologic Europe
Horizon Park
Leuvenseesteenweg 510, BUS 31
1930 Zaventem, Belgium
Patent Applied For
CAUTION: To prevent electrical shock, do not remove cover. No user serviceable parts inside. Refer servicing to qualified service personnel.
Model DROC:
Serial No.:
Date of Manufacture:
0044
This product complies with applicable provisions of the following standards:
EN60601-1 EN60601-1-2
IEC60601-1-4
This product complies with radiation performance standards under the US Federal Food, Drug and Cosmetics Act.
MC20_357_1.CDR

Radiographic Table Labels

The location of the Radiographic Table identification labels are shown in Figure 1-3.

Figure 1-3. Location of the Radiographic Table Identification Labels



Radiation Safety

Safety

Everyone associated with X-ray work must be familiar with the recommendations of the Center for Devices and Radiological Health (CDRH), the National Institute for Standards and Technology (NIST), the National Council on Radiation Protection (NCRP), and the International Committee on Radiation Protection (ICRP).

Be sure that all personnel authorized to operate the X-ray system are familiar with the established regulations of the authorities named above. All personnel should be monitored to ensure compliance with recommended procedures.

Current sources of information include:

- *National Council on Radiation Protection Report No. 33* (“Medical X-ray and gamma ray Protection for Energies up to 10 MEV-Equipment Design and Use”).
- *National Bureau of Standards Handbook No. 76* (“Medical X-ray Protection up to Three Million Volts”). Refer to NCRP Report No. 33.
- Current recommendations of the International Committee on Radiation Protection.

Although X-radiation is hazardous, X-ray equipment does not pose any danger when properly used. Be certain all operating personnel are properly educated concerning the hazards of radiation. Persons responsible for the system must understand the safety requirements and special warnings for X-ray operation. Review this manual and the manuals for each component in the system to become aware of all safety and operational requirements.

CAUTION

Incorrectly positioning the X-ray tube and Collimator could cause the X-ray field to be misaligned with the DirectRay Detector, resulting in unacceptable images.

WARNING

Ensure exposure parameters are properly adjusted within safety limits.

Manufacturer’s Responsibility

Although this equipment incorporates protection against X-radiation other than the useful beam, practical design does not provide complete protection. Equipment design does not compel the operator or assistants to take the necessary precautions; nor does it prevent the possibility of improper use (authorized or unauthorized persons carelessly, unwisely, or unknowingly exposing themselves or others to direct or secondary radiation). Allow **only** authorized, properly trained personnel to operate this equipment.

Be certain that all individuals authorized to use the equipment are aware of the danger of excessive exposure to X-radiation.

This equipment is sold with the understanding that the manufacturer, its agents, and representatives, do not accept any responsibility for overexposure of patients or personnel to X-radiation.

Furthermore, the manufacturer does not accept any responsibility for overexposure of patients or personnel to X-radiation generated by the equipment used in conjunction with the EPEX/Omniflex IV System components as a result of poor operating techniques or procedures.

No responsibility is assumed for any unit that has not been serviced and maintained in accordance with the technical service manual, or which has been modified or tampered with in any way.

Monitoring Personnel

Monitoring personnel to determine the amount of radiation to which they have been exposed provides a valuable cross-check to determine whether or not safety measures are adequate. This cross-check may reveal inadequate or improper radiation protection practices and/or serious radiation exposure situations.

The most effective method of determining whether the existing protective measures are adequate is the use of instruments to measure the exposure (in rads). This measurement should be taken at all locations where the operator, or any portion of the operator’s body, may be inadequately shielded during exposure. Exposure must never exceed the accepted tolerable dose.

A frequently used, but less accurate, method of determining the amount of exposure is placement of film at strategic locations. After a specified period of time, develop the film to determine the amount of radiation. Fluorescent screens (used in a darkened room) may also be used to detect excessive radiation.

A common method of determining whether personnel have been exposed to excessive radiation is the use of film badges. These are X-ray sensitive film enclosed in a badge that incorporates metal filters of varying degrees of transparency to X-ray radiation. Even though this device only measures the radiation reaching the area of the body on which it is worn, it does provide an indication of the amount of radiation received.

Radiation Protection Survey

A radiation protection survey must be made by a qualified expert after every change in equipment or change in operating conditions which might significantly increase the probability of personnel receiving more than the maximum permissible dose equivalent.

Restrictions on Use

The user is responsible for ensuring that the application and use of the EPEX/Omniflex IV System does not compromise the patient contact rating of any equipment used in the vicinity of, or in conjunction with, the system.

The use of accessory equipment and/or hardware not complying with the equivalent product safety and EMC requirements of this product may lead to a reduced level of safety and/or EMC performance of the resulting system. Consideration relating to the choice of accessory equipment used with this product shall include:

- The use of the accessory in the patient vicinity
- Evidence that the safety certification of the accessory has been performed in accordance with the appropriate IEC 60601-1 and/or IEC 60601-1-1 Harmonized National Standards
- Evidence that the EMC certification of the accessory has been performed in accordance to the IEC 60601-1-2 Harmonized National Standards

Some components of the EPEX/Omniflex IV System have been classified as to acceptable applications of use in accordance with Information Technology Equipment regulations.

CAUTION

Observe all safety precautions recommended by the accessory equipment manufacturer in the user documentation provided with the equipment. With a laser bar code reader, observe any laser precautions.

The hardware specified for use with the EPEX/Omniflex IV System has been selected, tested, and verified by Del to meet the intended applications. All specified hardware meets applicable regulatory agency requirements for those countries where it is offered for sale with respect to its intended applications. Consult the user documentation included with the equipment for specific information relating to product safety and EMC compliance.

Chapter 2
General Information

This chapter provides general information about the EPEX/Omniflex IV System.

Contents

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What Is the EPEX/Omniflex IV System?	2-2
Major System Components	2-4
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What Is the EPEX/Omniflex IV System?

The EPEX/Omniflex IV System is a direct-to-digital, fully integrated, imaging system for general purpose outpatient radiology. The EPEX/Omniflex IV System utilizes a single digital detector to perform most general radiography procedures.

The DirectRay technology directly captures and converts X-ray energy into a digital image. The system acquires and transmits image data for hardcopy, soft display, or storage via Ethernet using DICOM protocols.

Typical radiographic assessment protocols for general radiography include views of the spine, chest, abdomen, skull, and orthopedic skeletal/ extremity examinations. The versatility of the radiographic system operation provides for the following quickly and efficiently:

- Accessing and/or entering of patient demographics.
- Accurate, flexible, and unencumbered alignment of the diagnostic source to both the anatomy of interest and the image receptor for any required radiographic projection of both immobilized and ambulatory patients, either upright or recumbent, for any patient size or weight from small infants to obese adults.
- Rapid, error-proof procedure configuration, image acquisition, and quality control softcopy review. The Generator and X-ray tube output requirements accommodate any patient size or weight from small infants to obese adults.
- High-quality softcopy and/or hardcopy network transmission image review and archive of accepted examinations.

The EPEX/Omniflex IV System consists of the following components:

- X-ray Generator
- Overhead Tube Crane (OTC)
  - Collimator
  - X-ray Tube
- Radiographic Table
  - Automatic Exposure Control
  - DirectRay Detector
- DirectRay Console
  - Image Preview Monitor
  - Pointing Device
  - Keyboard
  - Prep/Expose Switch
  - Modem
  - DirectRay Controller
  - WAMI
  - System CPU

Major System Components

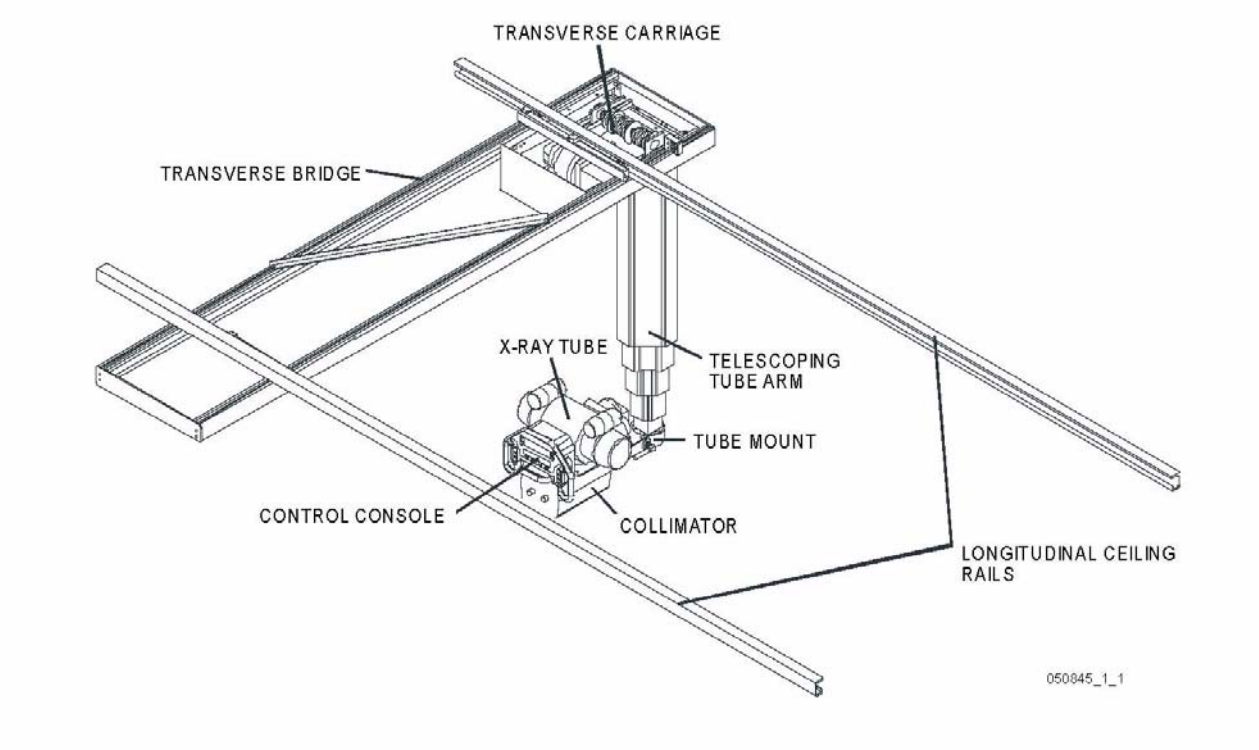
Overhead Tube Crane (OTC) Components

The OTC, the EPEX/Omniflex IV subsystem that hangs from the ceiling, includes the following components:

- LONG rails—there are two LONG (longitudinal) rails. These rails are fixed to the ceiling structure (usually I-beams and Unistrut rails). The LONG rails support the LAT rails and allow their movement in the left and right directions.
- LAT rails—there are two LAT (lateral) rails. They are supported by the LONG rails by roller bearings. The LAT rails support the OTC components and allow their movement in the back and forth directions.
- Electromagnetic brakes (not shown)—these brakes are controlled by switches on the Console. They hold the X-ray tube stationary during operation. They are located on the LAT rail and on the OTC Bearing Block.
- OTC—supports the X-ray tube, the Collimator, and the Control Console. It allows these components to move vertically, using an integrated counterpoised spring. Two pivot points at the base of the five-element telescope allow the remaining components to rotate horizontally and vertically to preset detented positions.
- X-ray Tube—the X-ray tube contains an anode and cathode to generate and direct the X-rays through the Collimator to the DirectRay Detector in the Bucky.
- Collimator.

For an illustration of the OTC components, refer to Figure 2-1 on page 2-5.

Figure 2-1. Overhead Tube Crane Components



Radiographic Table Components

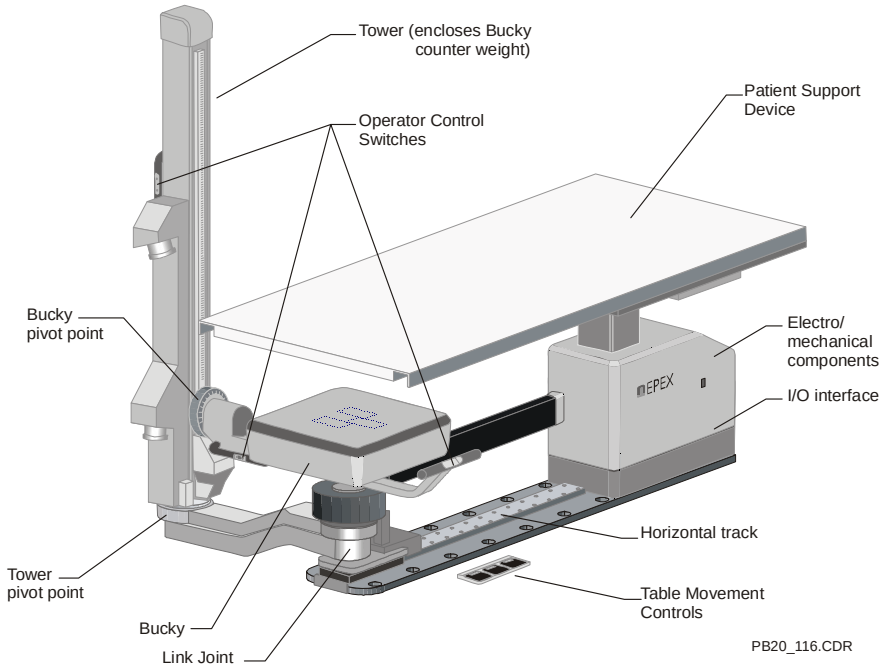
The table components are:

- Patient Support Device—supports up to 450 lb and moves vertically, left and right, and fore and aft.
- Table Movement Controls—a three-switch foot pad that moves around the floor for the operator's convenience. The first switch releases the brakes allowing the operator to manually move the table back, forth, left, and right. The second switch moves the table up. The third switch moves the table down.
- Tower—controls the veritcal movement of the Bucky. It contains a counterweight to offset the Bucky's weight. A ratchet along its face detents the Bucky vertically about every 0.3 in. The Tower pivot point allows the Bucky to rotate around the Tower and detent in 45° increments.
- Link Joint—allows the Tower to rotate around the end of the table to the other side. It detents in 45° increments.
- Bucky—houses the DirectRay Detector, the Grid, and the Ion Chamber. The Bucky rotates around the Bucky pivot point 135° in either direction detenting in 15° increments.
- Horizontal Track—guides the Bucky/Tower assembly in the back and forth direction.
- Operator Control Switches—allows the operator to release several electro-mechanical brakes to move the bucky to almost any position.

Note: *If you step on the up and down controls at the same time, the patient support device does not move in either direction and there is no danger of harming the electronics.*

For the locations of the Table components, refer to Figure 2-2 on page 2-7.

Figure 2-2.
Table Components



DirectRay Console Components

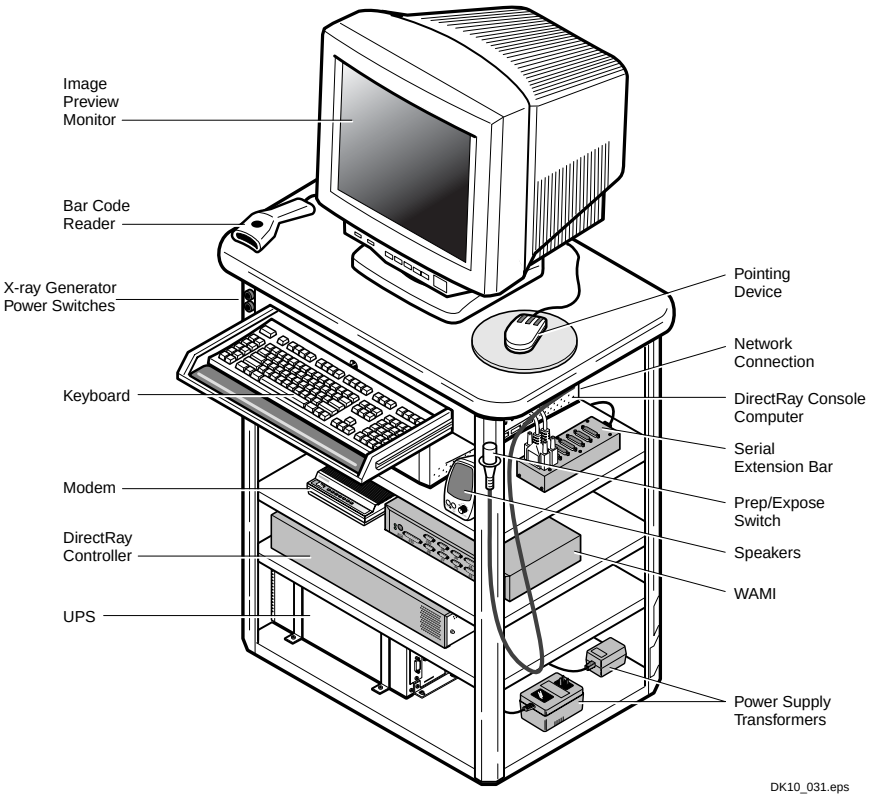
The DirectRay Console is used to enter patient information, initiate the exposure process, preview captured images, and accept or reject captured images. From here, the operator can select techniques through mouse control; view, recall, and manage images stored in its database; or distribute images, for example to a printer or archive.

The DirectRay Console components are:

- Image Preview Monitor—a CRT display that the operator uses to view the EPEX/Omniflex IV System. The monitor is used to run software, calibration, and diagnostics.
- Bar Code Reader—if the hospital preprocesses patient information and prints it on a bar code, the operator can use the Bar Code Reader to input this information to the system.
- Keyboard and Pointing Device—the operator uses the keyboard and pointing device to control the EPEX/Omniflex IV System functions through the software.
- Prep/Exposure Switch—used to signal the system to take the preview exposure.
- X-ray Generator Power Switches—the upper switch turns the Generator power on and the lower switch turns the Generator power off.

For the locations of the DirectRay Console components, refer to Figure 2-3.

Figure 2-3. DirectRay Console Components



Generator Components

The Generator provides the power and interfacing to operate X-ray tubes, the Bucky, and digital imaging systems. Refer to Figure 2-4 on page 2-10.

The Generator components and functions are:

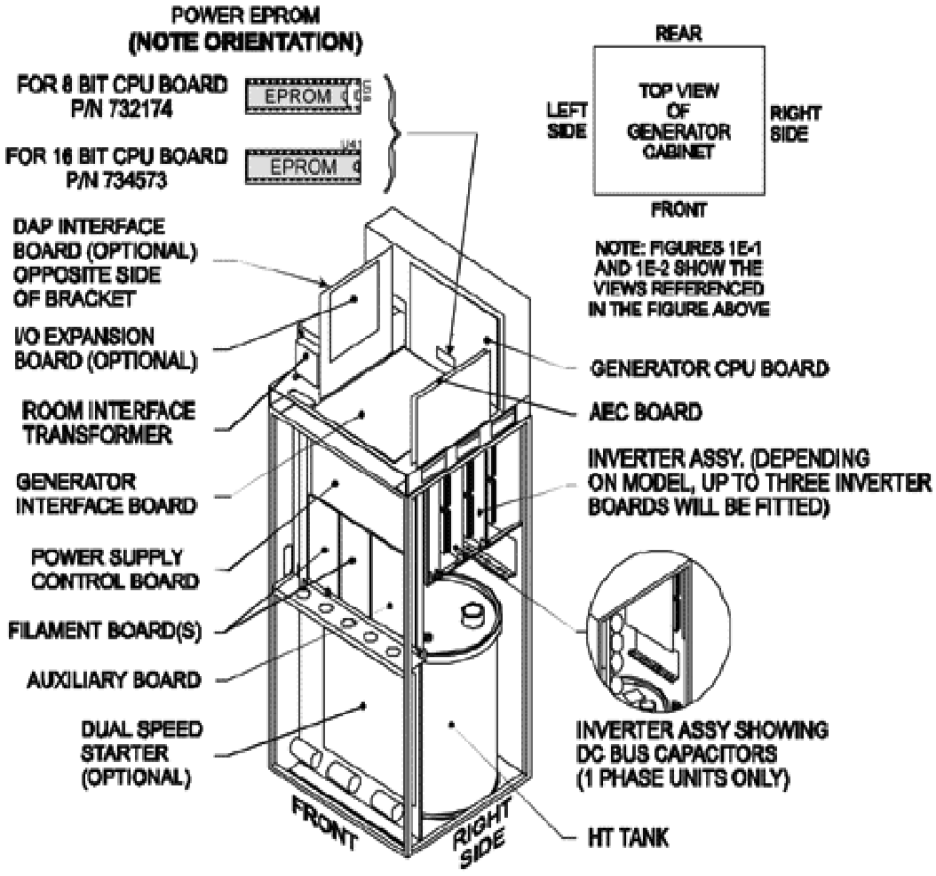
- High frequency Generator
- One tube operation
- Dual filament supplies
- Dual speed X-ray tube stator supply
- Optimal matching of X-ray tubes by PROMs
- Optional AEC, up to four inputs
- Optional ABS with kVp or kVp/mA fluoro stabilizer
- X-ray tube protection. The Generator allows setting the following limits:
  - Maximum mA, adjustable for each focal spot
  - Maximum kVp, adjustable for each X-ray tube
  - Maximum kW, adjustable for each focal spot
  - Maximum filament current limit, adjustable for large and small focal spots
  - Anode heat warning and anode heat alarm levels
- Calibration features:
  - Microprocessor design allows all calibration and programming to be performed via the Console.
  - mA calibration is automated.
  - Messages and diagnostic information: For users and service personnel, the Generator console displays various messages indicating status or equipment problems. The user is prompted in case of errors.
  - Error log stores the last 200 errors and associated Generator settings.
  - Service and diagnostic information available via a laptop computer (optional).
  - kVp range: radiography 40 to 150 kVp.

- mA range: radiography 25 to 320 mA (30 kW), 630 mA (50 kW), 800 mA (65 kW), and 1000 mA (80 kW).
- mAs range: tube dependent, max 1000 mAs.
- time range: radiography 2.0 to 6300 ms.

- Repetitive self checks of the Generator functions that provide a display of system faults and operating errors

For the locations of the Generator components, refer to Figure 2-4.

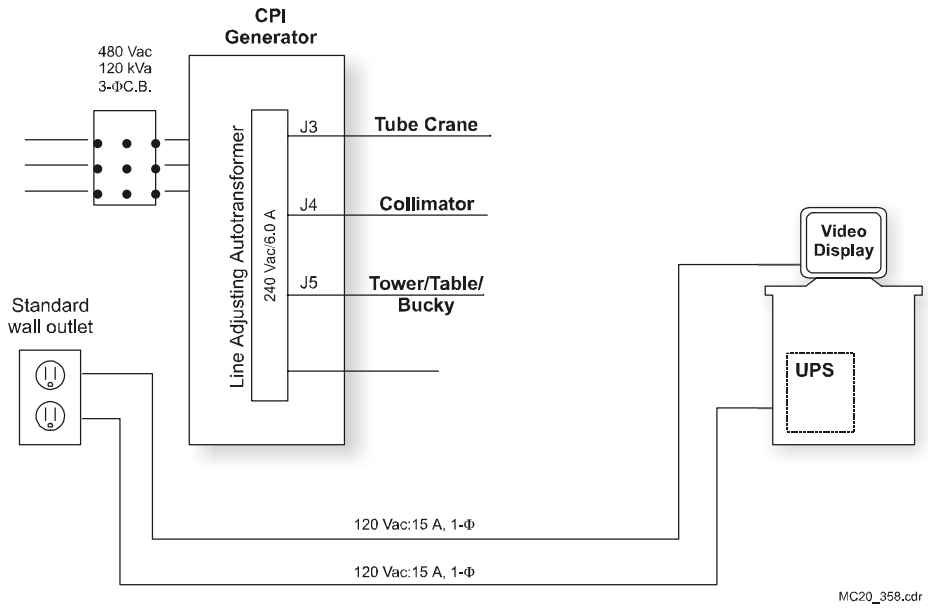
Figure 2-4.
Generator Components



Input Power

Power to the Bucky and Collimator is supplied by the line-adjusting transformer in the lower Generator cabinet.

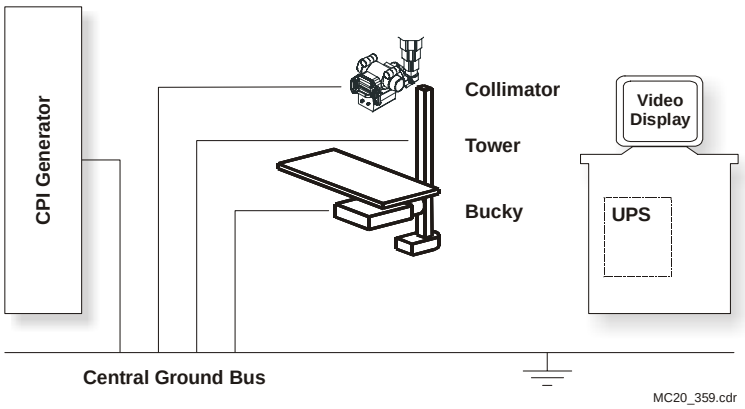
Figure 2-5.
Input Power



System Earth Grounding Map

The ground impedance from the central grounding point to any subsystem peripheral must **not** exceed 0.1 Ohms.

Figure 2-6.
Grounding Map



Collimator

The Collimator is attached to the OTC. Refer to Figure 2-7. The Collimator control panel is shown in Figure 2-8. For further information on the Collimator, refer to the Collimator and OTC service manuals that came with the system.

Figure 2-7.
Collimator Attached to the OTC

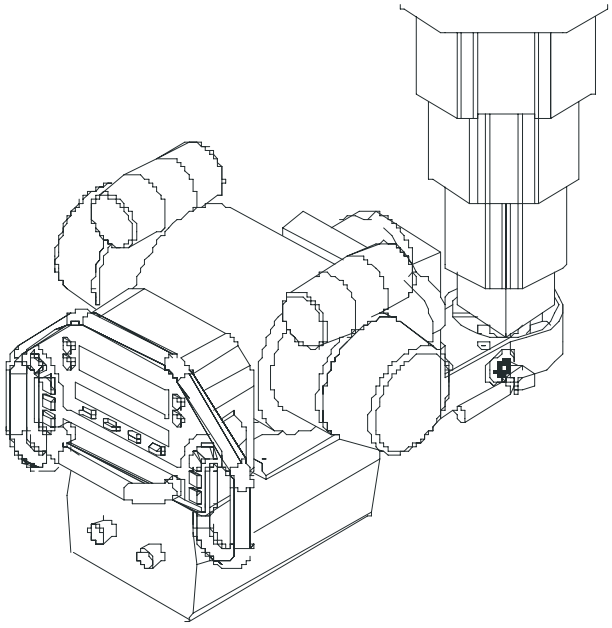
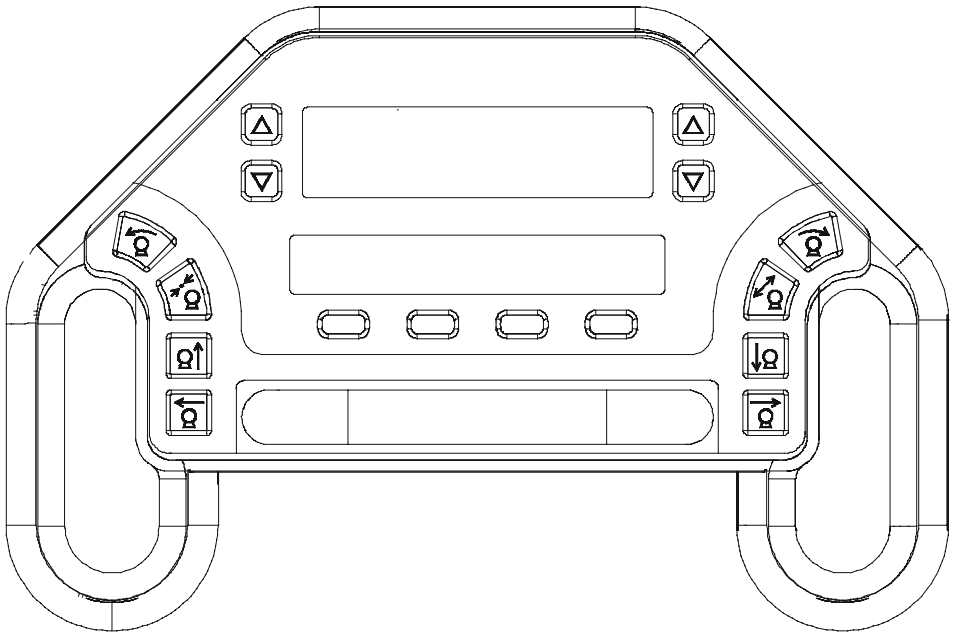


Figure 2-8.
Collimator Control Panel



Compatibility Certified Components

This topic lists the components compatible with the EPEX/Omniflex IV System.

Component	Model Number
DirectRay Console	DROC R/E 120 & 230 (Certified Component)
Generator	various
DirectRay Detector	DR0033
DirectRay Controller	DR0014
Ion Chamber	ICX 936
X-ray Tube	B-150 (Certified Component)
Collimator	CT010 (Certified Component)
Radiographic Table	010-1172

Compatible Output Devices

If the image is acceptable, the data is stored or printed. For an illustration of sending the images via DICOM format to the printer, refer to the illustration below. The EPEX/Omniflex IV System supports output to DICOM Print Service Class and DICOM Storage Service Class providers. The details of compatible PACs Devices and Printers are shown in Table 2-1 on page 2-15 and Table 2-2 on page 2-16. Contact your representative for an updated compatibility list.

Figure 2-9.
Peripheral Devices

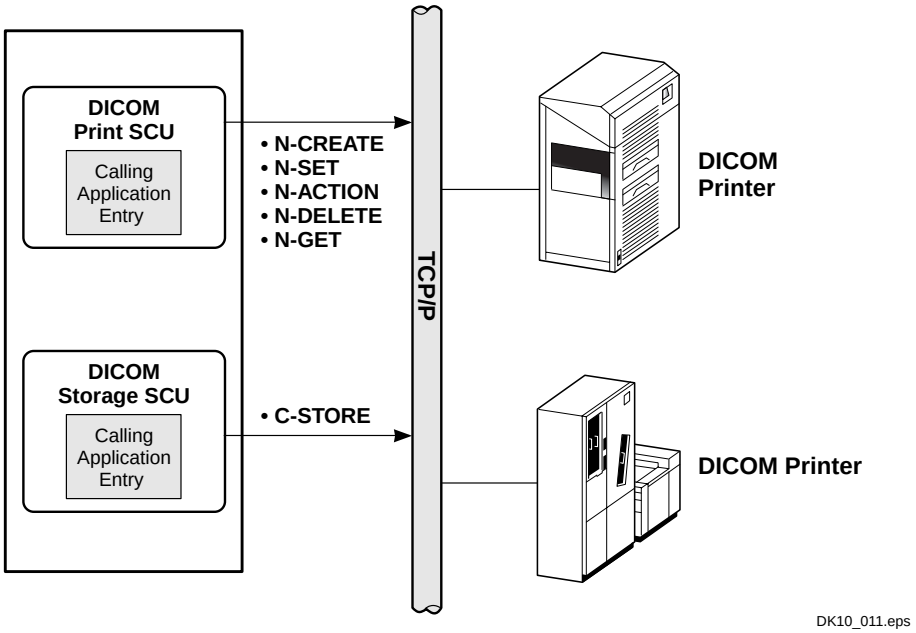


Table 2-1. PACs Devices

Manufacturer	Model	Type	DICOM Service	Software/ Platform Basis	Conformance Version	Comments
Agfa	Impax 3.5	PACs	Store			Complete
Cannon		Wrkst	Store	Rational Imaging	Ver. 3.2 Jan 1998	Complete
GE Medical	IIS	PACs	Store		P/N 4361668 Rev 01, 1998	Complete
Kodak	RadWorks	Wrkst	Store	Applicare	DCM-1007-002/ 00-002 Ver. 2.1a Aug 1999	Complete
Kodak/ Cemax-Icon	Archive	Wrkst	Store	Macintosh		In Progress
Kodak/ Cemax-Icon	Archive NT	Archiv	Store		SW Ver. 3.5.0 Doc#171-0016-00 Mar 1999	Complete
Kodak/ Cemax-Icon		Wrkst	Store	Windows NT		Complete
Siemens	Magic Store	Archiv	Store			In Progress
Siemens	Magic View	Wrkst	Store		VB32A Rev. 3.0, Aug 1999	Complete
Sterling (now Agfa)	iiSys	PACs	Store	ISG	ISG 1998-00352 Rev. 1.1 Mar 1998	Complete

Table 2-2. Printers

Manufacturer	Model	Type	DICOM Service	Interface	Conformance Version	Comments
Agfa	5200	Printer	Print	MG 3000	PMS Ver. 3.31 Jul 1999	Extension of Drystar Validation
Agfa	Drystar 3000	Printer	Print	MG 3000 (internal)	PMS Ver. 3.31 Jul 1999	Complete
Agfa	LR3300	Printer	Print	MG 3000	PMS Ver. 3.31 Jul 1999	Extension of Drystar Validation
Fuji	FM DP–L	Printer	Print	Fuji Network Print Server	FN-PSS551 Oct 1999 3rd Edition	Complete
Kodak	1120	Printer	Print	DICOM Print Server 9410	#2E0383 Rev-D SW V 3.1 Feb 2000	In Progress
Kodak	2180	Printer	Print	DICOM Print Server 9410	#2E0383 Rev D SW V 3.1 Feb 2000	In Progress
Kodak/Imation	Dryview	Printer	Print	PACs Link 99410 Acq. Sys.	96-0000-4147-3, V1.0, Jul 1998	Complete
Sterling (now Agfa)	Contact 400	Printer	Print	Internal	PMS Jan 1999	Complete
Sterling (now Agfa)	Digital 400	Printer	Print	Helios Print Server (DPS)	HPS Ver. 1.1L Oct 1997	Complete
Sterling (now Agfa)	LP 400/300	Printer	Print	LINX Gateway	LNSS3_DCC_))2 93 Ver. 4.1	Complete

Chapter 3
Installing the System Hardware

This chapter describes the basic installation of the EPEX/Omniflex IV System.

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Overview

This topic details the tasks you must do **before** installing the EPEX/Omniflex IV System. The topics covered are:

- Safety equipment needed
- Personnel required
- Tools and equipment needed
- Room preparation
- Checking the ceiling

Staging the System

Before shipping the system to the site, Del stages the entire system at the factory. Therefore:

- The longitudinal rails are precut to the proper length
- The cables are properly bundled for your site layout

Safety Equipment

The Overhead Tube Crane (OTC) consists of heavy rails, cables, cable carriages, and heavy equipment that hang from the ceiling. While installing this equipment you must protect yourself from falling assemblies, tools, and miscellaneous fasteners and components that may cause serious injury to you and/or other installers in the room.

Lifting and moving some of the assemblies can be dangerous because of their weight. Wear a back support when lifting heavy objects.

The following safety items must be worn during the installation of the equipment suspended overhead:

Safety hat

Safety glasses

Back support

Safety shoes

Personnel Required

Do not attempt to install this equipment with less than two people—three people is preferable. Each person should wear the proper safety equipment during the installation.

Tools and Other Equipment

Before starting the installation, ensure that you have the proper equipment to do the job.

Hammers: A heavy hammer such as a 32 oz ball-peen. Use this with a block of wood to adjust rails and end caps. You can also use a heavy plastic or rubber mallet.

Pliers: An assortment of pliers and cutters.

Power tools: Hammer drill, power hand drill.

Screw drivers: Varied flat blade and Phillips head drivers.

Wrenches: Assorted English and metric box and opened wrenches.

Prying tools: You may need various prying bars to remove the equipment from the crates.

Hand tools: You may need a hand saw or equivalent to remove the equipment from the crates.

Measuring tools: You need a 25 ft tape rule and a micrometer.

Allen wrenches: You need a varied assortment of Allen wrenches, including keys and T-handles, in English and metric sizes.

Leveling device: Digital levels (various lengths), plumb bobs, chalk lines, and/or laser alignment devices.

Clamps: You may want to use clamps to secure various movable parts on the system if there is no power to activate the brakes.

Lifting device: Minimum 650 lb capacity, minimum 10 ft vertical travel pallet jack.

Parts To Be Returned to Del

The following parts must be returned to Del:

- Caster Bars from the Radiographic Table
- Drilling Plate
- Leveling Plate

Room Preparation

The following warnings must be complied with before installation begins.

WARNING

Failure to comply with these warnings may cause serious or fatal bodily injury and degrade the unit's safety level.

WARNING

Ensure that the construction and load capacity of the ceiling are sufficient for the installation of this equipment.

WARNING

Ensure that the central ground terminal of the room has a resistance in accordance with the regulations in force.

WARNING

Ensure that the room line input is protected by means of a differential breaker calibrated for a maximum leakage current of 30 mA.

WARNING

Ensure that the room emergency circuit is present and designed in accordance with the regulations in force.

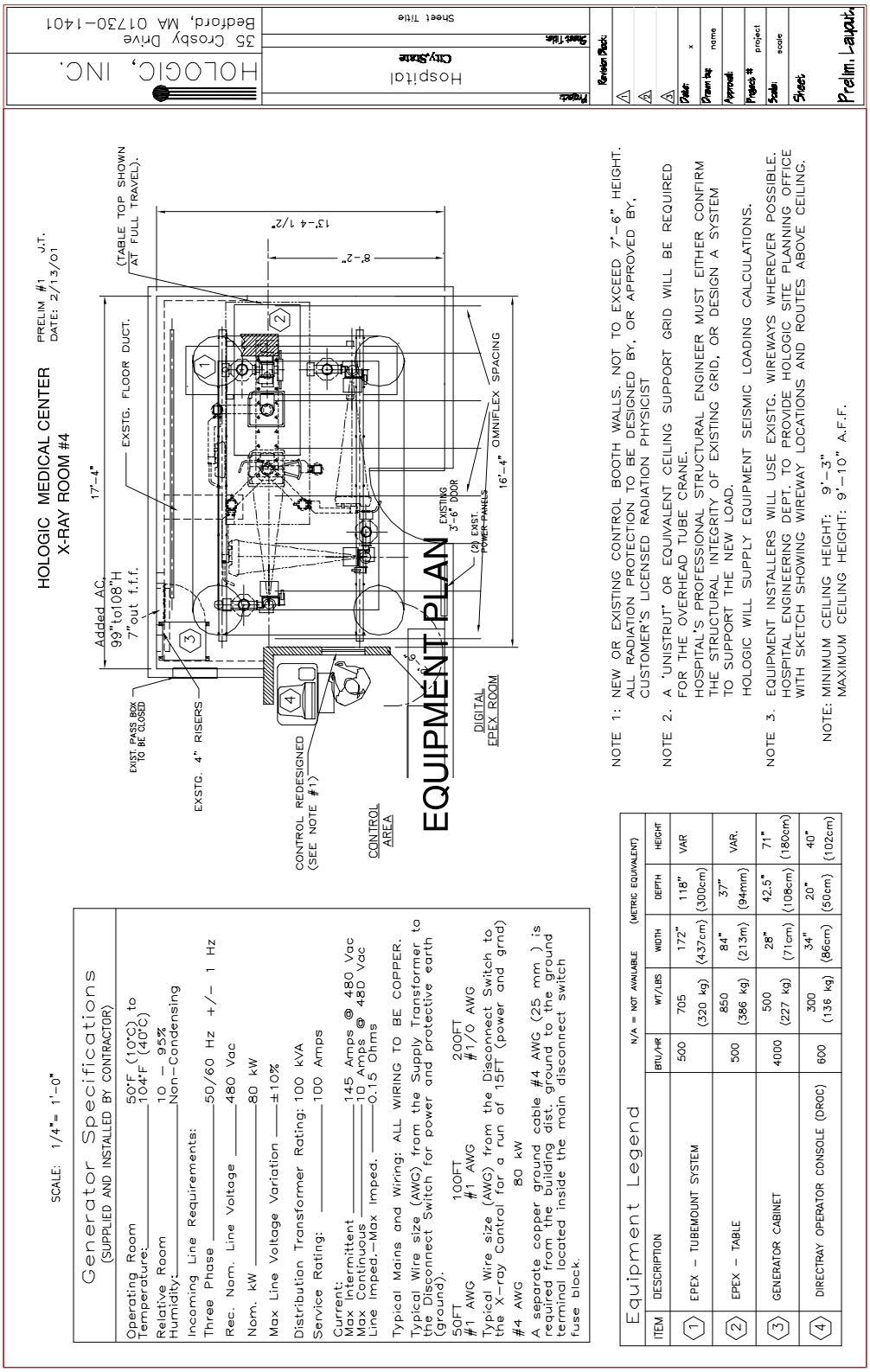
WARNING

Ensure that the walls of the room have been prepared to prevent the emission of scatter radiation into adjacent areas (usually the walls are lined with lead).

Also, ensure that:

- The floor is level.
- A qualified facility official approves the room before installation begins.
- There is sufficient clearance between the equipment and the walls and doors, and so on.

Figure 3-1. Typical Site Planning Drawing


HOLOGIC, INC.
35 Crosby Drive
Bedford, MA 01730-1401
Hospital
City, State
Sheet Title
HOLOGIC MEDICAL CENTER
X-RAY ROOM #4
PRELIM #1 J.T.
DATE: 2/13/01
SCALE: 1/4"= 1'-0"
EQUIPMENT PLAN
Added AC. 99°to108°H 7"out f.f.f.
EXSTG. FLOOR DUCT.
(TABLE TOP SHOWN AT FULL TRAVEL).
17'-4"
13'-4 1/2"
8'-2"
16'-4" OMNIFLEX SPACING
EXISTING 3'-6" DOOR
(2) EXIST. POWER PANELS
EXIST. PASS BOX TO BE CLOSED
EXSTG. 4" RISERS
CONTROL REDESIGNED (SEE NOTE #1)
CONTROL AREA
DIGITAL EPEX ROOM
NOTE 1: NEW OR EXISTING CONTROL BOOTH WALLS, NOT TO EXCEED 7'-6" HEIGHT. ALL RADIATION PROTECTION TO BE DESIGNED BY, OR APPROVED BY, CUSTOMER'S LICENSED RADIATION PHYSICIST
NOTE 2. A 'UNISTRUT' OR EQUIVALENT CEILING SUPPORT GRID WILL BE REQUIRED FOR THE OVERHEAD TUBE CRANE. HOSPITAL'S PROFESSIONAL STRUCTURAL ENGINEER MUST EITHER CONFIRM THE STRUCTURAL INTEGRITY OF EXISTING GRID, OR DESIGN A SYSTEM TO SUPPORT THE NEW LOAD. HOLOGIC WILL SUPPLY EQUIPMENT SEISMIC LOADING CALCULATIONS.
NOTE 3. EQUIPMENT INSTALLERS WILL USE EXISTG. WIREWAYS WHEREVER POSSIBLE. HOSPITAL ENGINEERING DEPT. TO PROVIDE HOLOGIC SITE PLANNING OFFICE WITH SKETCH SHOWING WIREWAY LOCATIONS AND ROUTES ABOVE CEILING.
NOTE: MINIMUM CEILING HEIGHT: 9'-3" MAXIMUM CEILING HEIGHT: 9'-10" A.F.F.
Generator Specification
(SUPPLIED AND INSTALLED BY CONTRACTOR)
Operating Room Temperature: 50°F (10°C) to 104°F (40°C)
Relative Room Humidity: 10 — 95% Non-Condensing
Incoming Line Requirements:
Three Phase ____ 50/60 Hz +/- 1 Hz
Rec. Nom. Line Voltage ____ 480 Vac
Nom. kW ____ 80 kW
Max Line Voltage Variation ____ ±10%
Distribution Transformer Rating: 100 kVA
Service Rating: ____ 100 Amps
Current:
Max Intermittent ____ 145 Amps @ 480 Vac
Max Continuous ____ 10 Amps @ 480 Vac
Line Imped.-Max Imped. ____ 0.15 Ohms
Typical Mains and Wiring: ALL WIRING TO BE COPPER.
Typical Wire size (AWG) from the Supply Transformer to the Disconnect Switch for power and protective earth (ground).
50FT #1 AWG 100FT #1 AWG 200FT #1/0 AWG
Typical Wire size (AWG) from the Disconnect Switch to the X-ray Control for a run of 15FT (power and grnd)
#4 AWG 80 kW
A separate copper ground cable #4 AWG (25 mm) is required from the building dist. ground to the ground terminal located inside the main disconnect switch fuse block.
Equipment Legend N/A = NOT AVAILABLE (METRIC EQUIVALENT)
ITEM | DESCRIPTION | BTU/HR | WT/LBS | WIDTH | DEPTH | HEIGHT
1 | EPEX - TUBEMOUNT SYSTEM | 500 | 705 (320 kg) | 172" (437cm) | 118" (300cm) | VAR
2 | EPEX - TABLE | 500 | 850 (386 kg) | 84" (213m) | 37" (94mm) | VAR.
3 | GENERATOR CABINET | 4000 | 500 (227 kg) | 28" (71cm) | 42.5" (108cm) | 71" (180cm)
4 | DIRECTRAY OPERATOR CONSOLE (DROC) | 600 | 300 (136 kg) | 34" (86cm) | 20" (50cm) | 40" (102cm)
Revision Block:
Drawn by: x
Approved: name
Project #: project
Scale: scale
Sheet:
Prelim. Layout

EPEX/Omniflex IV System Installation Checklist

As the installation progresses, use the checklist as a guide. The EPEX/Omniflex IV System Checklist provides a reminder of the critical steps for installation.

EPEX Omniflex System Installation Checklist

- ❑ Delivery Completed
- ❑ Equipment Unpacked
- ❑ Return the Detector Array TempTale®
- ❑ Positioning the Equipment
- ❑ Operator Console Installation:
  - ❑ UPS Charged and Grounded
  - ❑ CPU Connected
  - ❑ Array Controller
  - ❑ WAMI
  - ❑ Monitor, Cabled for DRAC and Operator Console CPU
  - ❑ Keyboard, Pointing Device, Barcode Reader
  - ❑ Modem
  - ❑ Serial Extension Bar
  - ❑ Remove Casters
  - ❑ Seismic Anchoring (if applicable)
- ❑ X-ray System Installation:
  - ❑ Position Generator
  - ❑ Asemble the Electroncs Box on the Generator
  - ❑ Verify Line Voltage
  - ❑ Configure Generator Mains
  - ❑ Check Secure Board Seating
  - ❑ Verify Internal Connections
  - ❑ Install High Voltage Transformer Assembly (outside U.S. only)
  - ❑ Seismic Anchoring (if applicable)
- ❑ Rails and OTC Installation
  - ❑ Install the Longitudinal Rails
  - ❑ Install the Lateral Rails
  - ❑ Install the Brakes
  - ❑ Install the OTC
  - ❑ Install the X-ray Tube
  - ❑ Install the Collimator
- ❑ Installing the Table
  - ❑ Place the table
  - ❑ Drill the Holes
  - ❑ Secure the Table
  - ❑ Assemble the Tower
  - ❑ Install the Detector Array
  - ❑ Cable to the Generator
- ❑ Electrical and Communication Lines:
  - ❑ Power Source to Generator
  - ❑ X-ray Room Warning Light
  - ❑ X-ray Room Door Interlock
  - ❑ X-ray Tube Anode and Cathode Cables
  - ❑ Operator Console Communication Connections
- ❑ Verify Alignment
- ❑ System Calibration
- ❑ Establish X-ray Light Field Coverage
- ❑ Network Connections
- ❑ Verify Modem Connection
- ❑ System Configuration
- ❑ Application Configuration
- ❑ System Acceptance Testing
- ❑ Return Templates and Caster Bars to Hologic

EPEX Omniflex System Checklist.cdr

Unpacking the Equipment

The equipment was carefully inspected and tested prior to shipment. Upon its arrival, inspect each container for damage. Unpack each component as soon as possible and conduct a thorough examination of the components. Do this in the presence of the carrier if at all possible. If damage is noted, take photographs of the damaged portions and immediately file a claim with the carrier. If the carrier is not notified within 15 days of delivery, the carrier cannot be held responsible.

Note: *Have a camera available to photograph any shipping damage.*

To verify the receipt of all parts prior to installation of the system, unpack the items as follows:

WARNING

Beware of sharp edges, splinters, pinch points, exposed nails, and staples when unpacking. Wear leather gloves.

Step	Action
1	Take the box shells off and uncrate in truck or loading dock area.
2	Refer to the packing list and verify that all components are present.
3	Visually check each component for damage.
4	Refer to the *DirectRay Shipping and Handling Guide* (PN 649947-000) for important information regarding the DirectRay Detector.

CAUTION

It is important to follow the directions for unpacking the DirectRay Detector and DirectRay Controller provided in the shipping and handling guide.

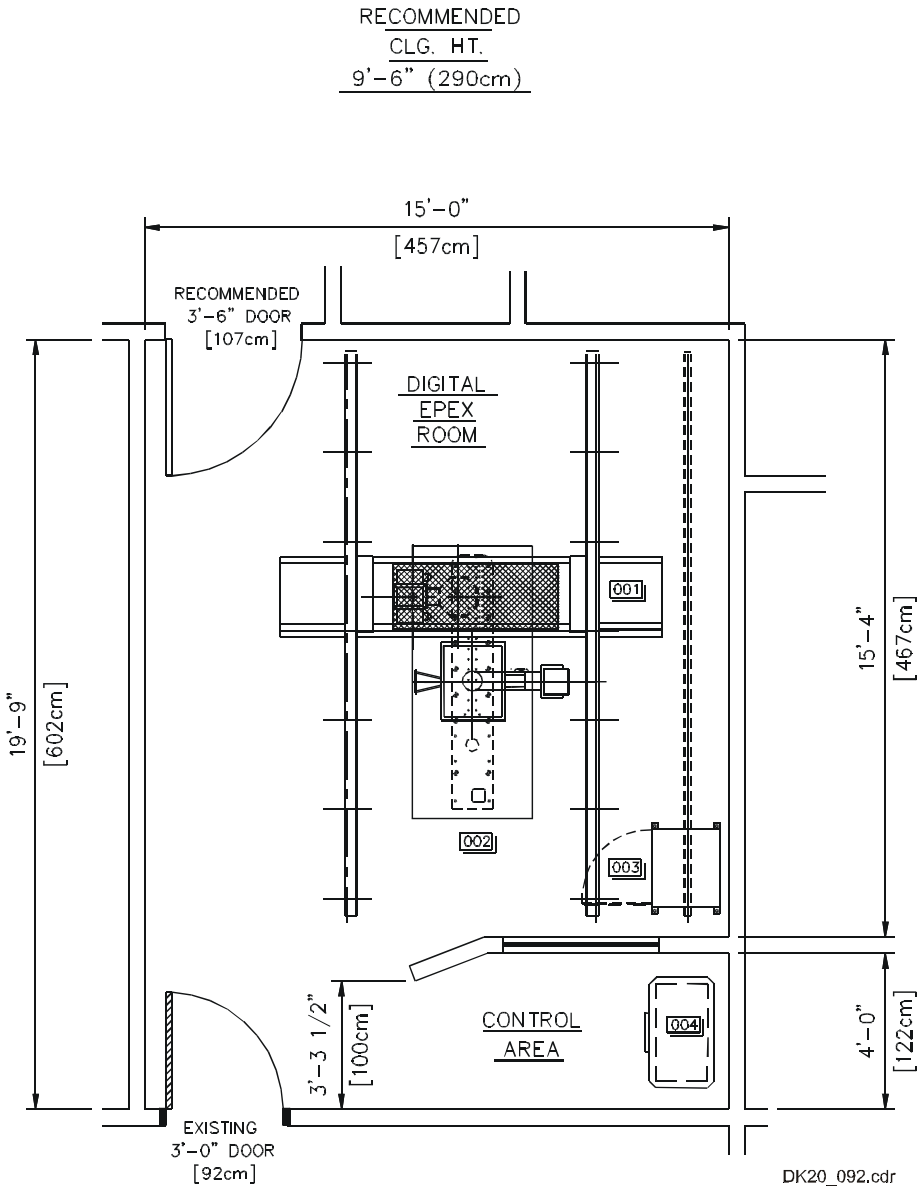
Step	Action
5	Return the TempTale temperature and humidity recorder from the DirectRay Detector packing to the Del Installation Coordinator.
6	Unpack the OTC and move it to the room.

CAUTION

Use two people to move the OTC.

Step	Action
7	Unpack the table. Refer to the *EPEX Radiographic Table Service Manual.*
8	Move all crates to either the room or to the storage area.

Figure 3-2. Typical EPEX/ Omniflex IV Room Layout



Positioning the Equipment

After the equipment has been moved to the room and unpacked, position the major components as shown on the site planning drawings. Ensure that there is enough room between the components and the walls or other equipment to complete the installation of components and cabling before final placement.

Positioning the Generator

Locate the Material Safety Data Sheet and the Configuration List and make copies. Originals are left on site. Send copies of these and the CDRH Workbook to the Installation Coordinator.

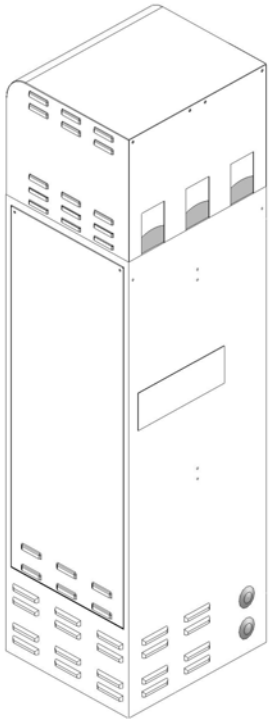
Position the Generator according to the room layout drawing near the final destination, leaving clearance for connections to the back panel. Refer to Figure 3-3.

Key points to remember in moving the Generator cabinet:

If the door size is 2134 x 864 mm (84 x 34 in.) or more, the Generator can be transported through the doorway while upright.

If the door size is less than 2134 x 864 mm (84 x 34 in.), the Generator must be tilted to the left to clear the doorway.

Figure 3-3.
Generator Cabinet
(Rear View)



To position the Generator:

Step	Action
1	Remove the Generator from the shipping packaging by cutting the bands that secure the cardboard sleeve to the shipping pallet.
2	Lift the shipping sleeve off the shipping pallet and put aside. The generator should be the only thing attached to the shipping pallet.
3	Locate the Material Safety Data Sheet and the Configuration List. ***Note:*** *These will need to be copied. Place a copy in a sleeve in the service manual and return the original to the Del Installation Coordinator.*
4	Check for shipping damage. Immediately contact the shipper if any damage is detected.
5	Unscrew the bolts that secure the Generator to the shipping pallet. ***Note:*** *There are four bolts, one in each corner.*
6	Use lifting straps to lift the Generator from the shipping pallet. ***Note:*** *Three to four people are required to accomplish this:three to lift and one to pull away the crate bottom.*

Figure 3-4.
Generator on Skid with Container Removed

CAUTION

Use caution if the straps are located at the back of the lower wiring channel.

Step	Action
7	Loosen the shipping seismic plates (by the leveling feet), flip them inside, and tighten them.
8	Move the Generator to a location close to the final position, leaving room to enable the cabling and assembly required.
9	Remove the front and side covers of the generator, including the bottom panels.

Positioning the DirectRay Console

Unpack the DirectRay Console at the loading dock. For instructions, refer to the *DirectRay Console Service Manual*.

EPEX/Omniflex IV System Wiring Diagrams

For information on how the EPEX/Omniflex IV components are connected, refer to Appendix E.

Installing the DirectRay Console

To install the DirectRay Console, move the DirectRay Console to its final location. Refer to the *DirectRay Console Service Manual* for installation instructions.

Installing the Rails

The first step for installing the OTC is to install the OTC rails and OTC bridge, according to the site planning drawing and the OTC service manual that came with the system.

Checking the Ceiling Preparation

Del hires an independent contractor to install the support beams and the Unistrut rails that hold the OTC. These beams must be installed and they must pass inspection before you can begin installation of the system. For an example of installed rails, refer to Figure 3-5.

A quick inspection of the support beam system should reveal:

- Rails have slots at the bottom for nuts and bolts to support the longitudinal rails
- Rails are leveled in both the longitudinal and transverse directions
- Rails are leveled to each other in the same horizontal plane

Figure 3-5.
Installed Rails

Room Layout

For an illustration of a typical room layout, refer to Figure 3-9 on page 3-17. However, for your installation, refer to the final site planning and the Radiographic Table to OTC drawings for specific details regarding the actual placement of equipment, including the floor location of the table.

The Radiographic Table to OTC layout drawing shows the preferred install location of the OTC rails in relation to the table. The dimensions in the Radiographic Table to OTC layout drawing allows positioning the OTC in A, B, or C detent SID setups.

Determining which detent setup(s) the customer will use enables you to optimize the room usage.

Figure 3-6. Setup Detent A

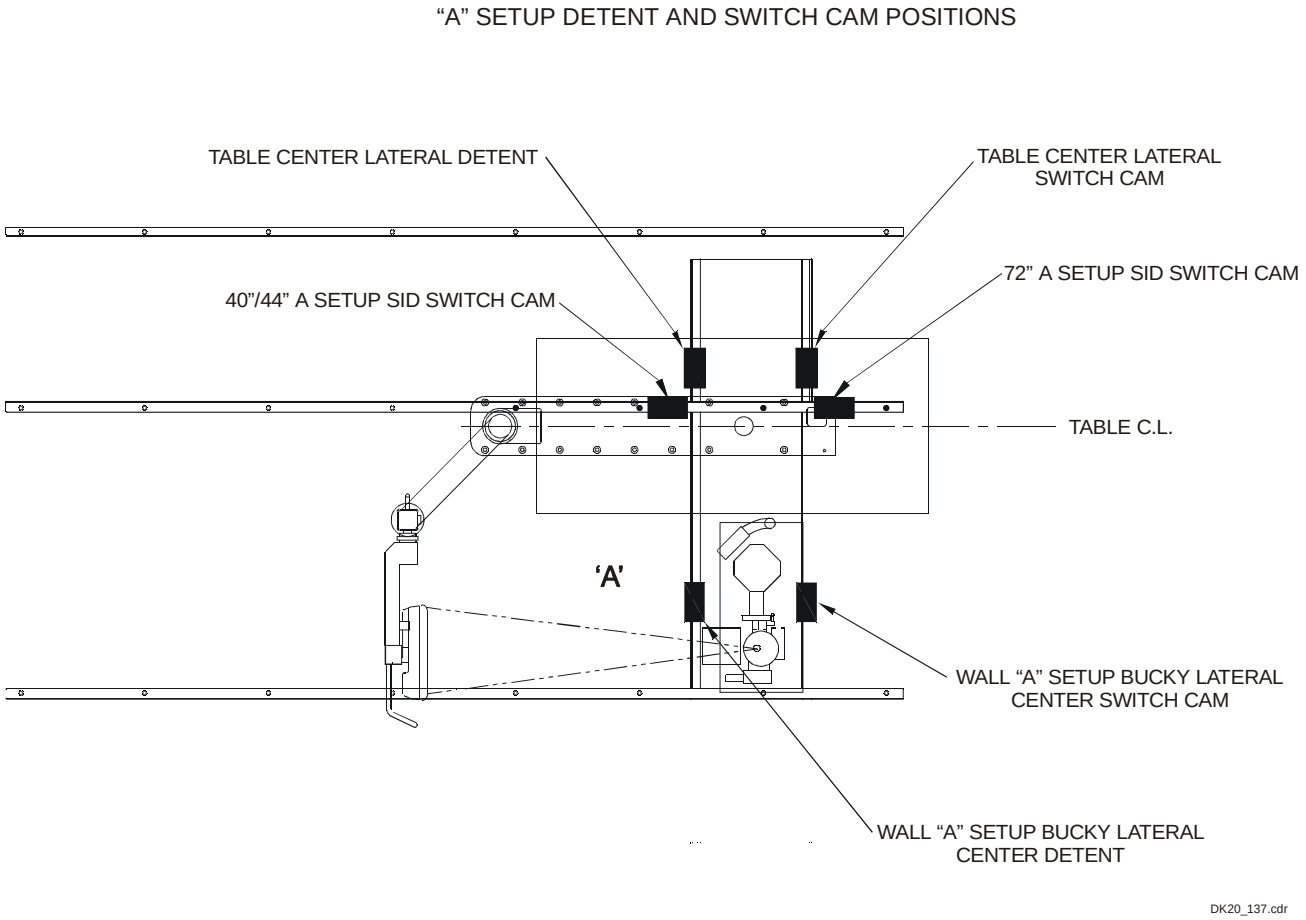

"A" SETUP DETENT AND SWITCH CAM POSITIONS
TABLE CENTER LATERAL DETENT
TABLE CENTER LATERAL SWITCH CAM
72" A SETUP SID SWITCH CAM
40"/44" A SETUP SID SWITCH CAM
TABLE C.L.
'A'
WALL "A" SETUP BUCKY LATERAL CENTER SWITCH CAM
WALL "A" SETUP BUCKY LATERAL CENTER DETENT
DK20_137.cdr

Figure 3-7. Setup Detent B

“B” SETUP DETENT AND SWITCH CAM POSITIONS

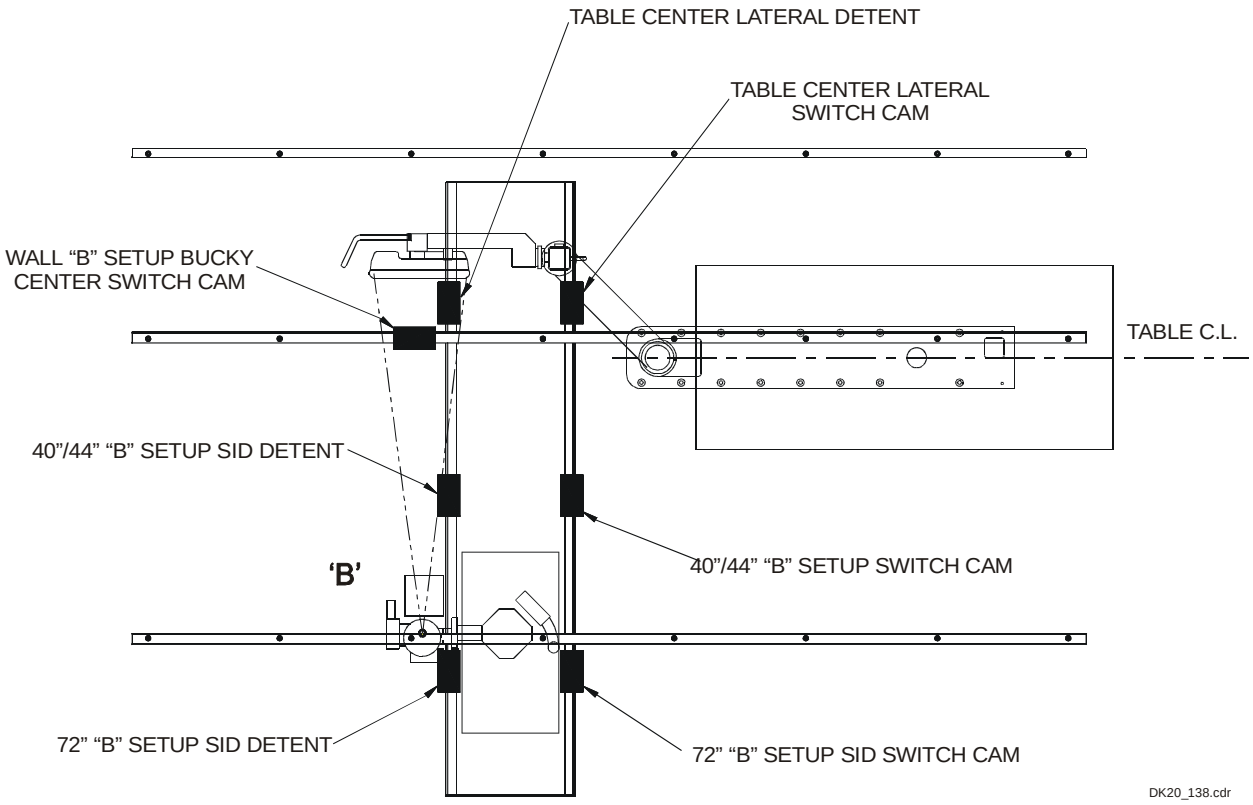
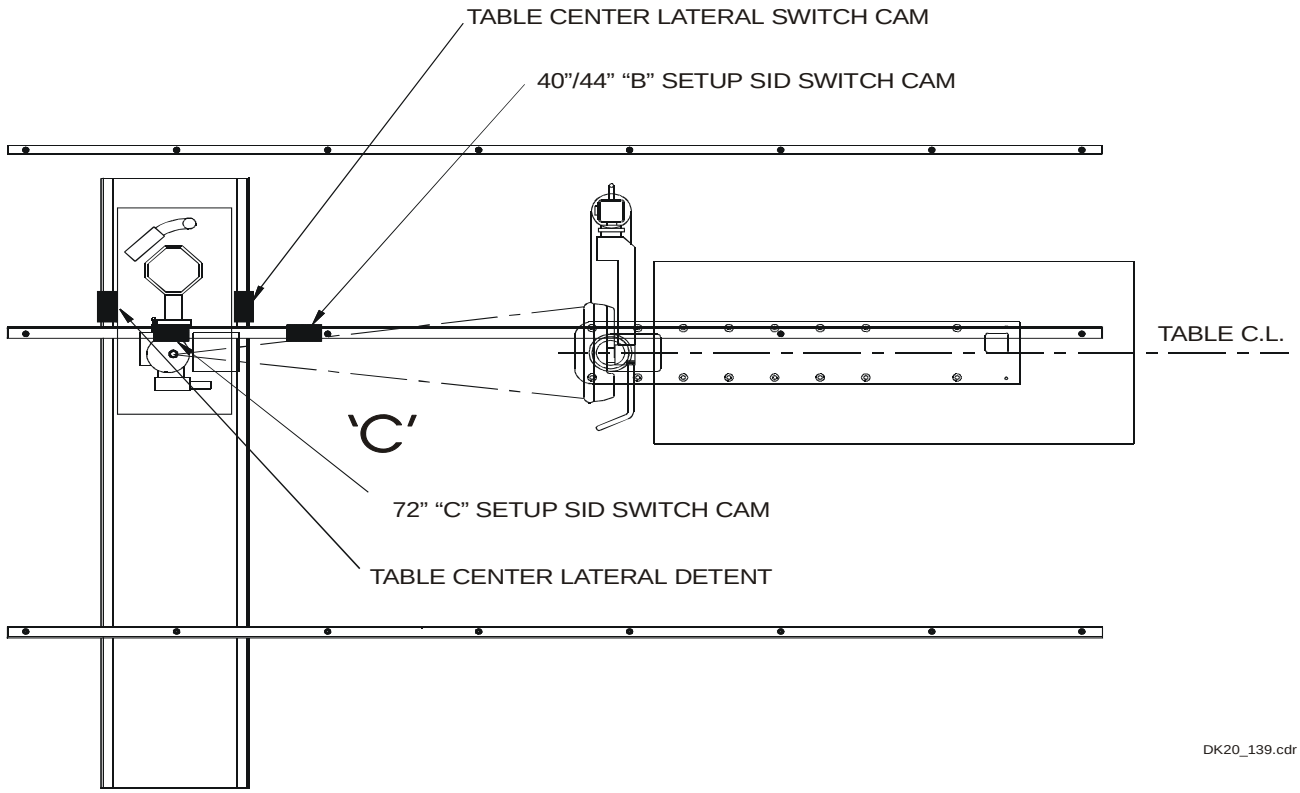


TABLE CENTER LATERAL DETENT
TABLE CENTER LATERAL SWITCH CAM
WALL “B” SETUP BUCKY CENTER SWITCH CAM
TABLE C.L.
40”/44” “B” SETUP SID DETENT
‘B’
40”/44” “B” SETUP SWITCH CAM
72” “B” SETUP SID DETENT
72” “B” SETUP SID SWITCH CAM
DK20_138.cdr

Figure 3-8. Setup Detent C


"C" SETUP DETENT AND SWITCH CAM POSITIONS
TABLE CENTER LATERAL SWITCH CAM
40"/44" "B" SETUP SID SWITCH CAM
TABLE C.L.
'C'
72" "C" SETUP SID SWITCH CAM
TABLE CENTER LATERAL DETENT
DK20_139.cdr

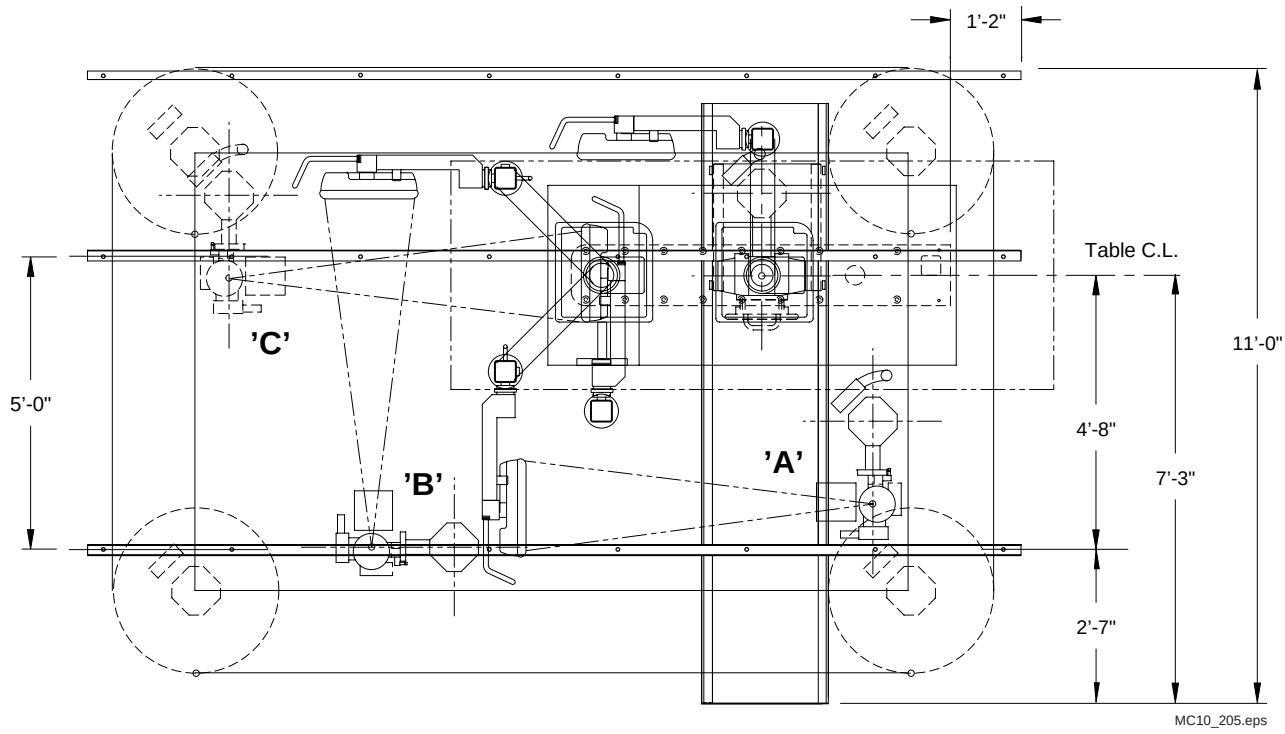
To wire the chest setup A, B, or C detent, refer to the OTC and Collimator service manuals that came with the system for proper configuration of the A, B, or C detent SID setup.

To prepare the room for the installation:

Step	Action
1	Review and thoroughly understand the final site planning drawing and the A, B, and C chest setup drawings before installing the equipment.
2	Ensure that there is sufficient clearance between the equipment and the walls, doors, and so on.
3	Upon reviewing the final site planning drawing and the A, B, and C chest setup drawings, identify the table orientation and the table location on the room floor.
4	Identify and mark the floor where the table's 4 in. square cable access hole is.

Step	Action
5	Identify and mark on the floor the table's longitudinal centerline.
6	Identify and mark a line on the floor perpendicular to the length of the table, 1 ft 2 in. towards the foot end, from the foot end side of the table. ***Note:*** *This dimension is the location for the end of the drape rail and longitudinal rails on the foot end side. Refer to Figure 3-9 on page 3-17.*
7	Identify and mark a line on the floor parallel with the centerline 4 ft 8 in. towards the front of the table. ***Note:*** *This dimension is the location of the center of the front longitudinal rail from the table centerline. This mark should be long enough to cover the length of the rail. Refer to Figure 3-9 on page 3-17.*
8	Identify and mark a line on the floor parallel with the centerline 5 ft 4 in. towards the rear of the table. This dimension is the location of the center of the rear longitudinal rail from the table centerline. This mark should be long enough to cover the length of the rail.
9	Use a plumb bob or a vertical leveled laser alignment device to transfer these dimensions to the ceiling.

Figure 3-9. Radiographic Table to OTC Layout Dimensions



Starting the OTC Installation

Refer to the OTC service manual that came with the system to begin the installation by installing the OTC on the rails.

Starting the Table Installation

Installing the table consists of the following procedures:

- Assemble the Integrated Radiographic Table according to its service manual
- Align and install the table to within 1/16 in. to the OTC logitudinal rails

Table to OTC Longitudinal Rail Alignment

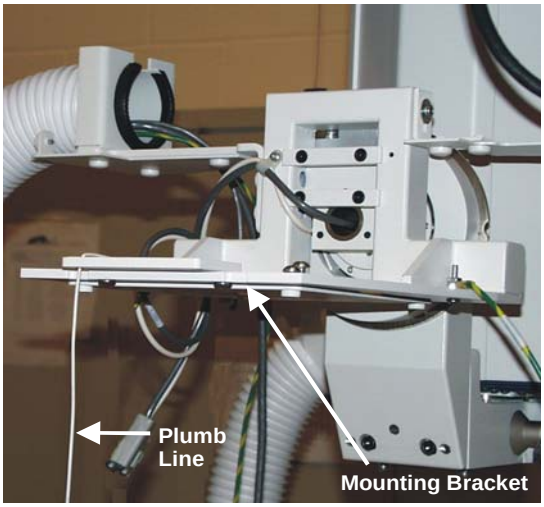
Aligning the Table to OTC Longitudinal Rails

Proper table alignment to the OTC longitudinal rails is important for accurate radiation alignment. The table base must be parallel with 1/16 in. to the OTC longitudinal rails.

To ensure the 1/16 in. parallel requirement:

Step	Action
1	Attach the plumb line to the X-ray tube mount and hover the plumb bob just above the floor surface. Refer to Figure 3-10 as an example.
2	Within 2 ft of the table base location, move the OTC along the entire length of the longitudinal rails and mark the line where the plumb bob ran.

Figure 3-10. Attaching the Plumb Line



Step	Action
3	Measure the distance of the marked plumb line to the table center line or table base edge.
4	Ensure the distance is within 1/16 in. for the entire length of the table.
5	To install the table, refer to the *EPEX Radiographic Table Service Manual*.

Finishing the OTC Installation

Install the following subsystem components by referring to their service manuals and interconnect diagrams.

- X-ray Tube
- Collimator
- Attach and run the OTC cables

X-ray Tube and Collimator Installation

Refer to the OTC service manual that came with the system.

Balancing the OTC

Refer to the OTC service manual that came with the system.

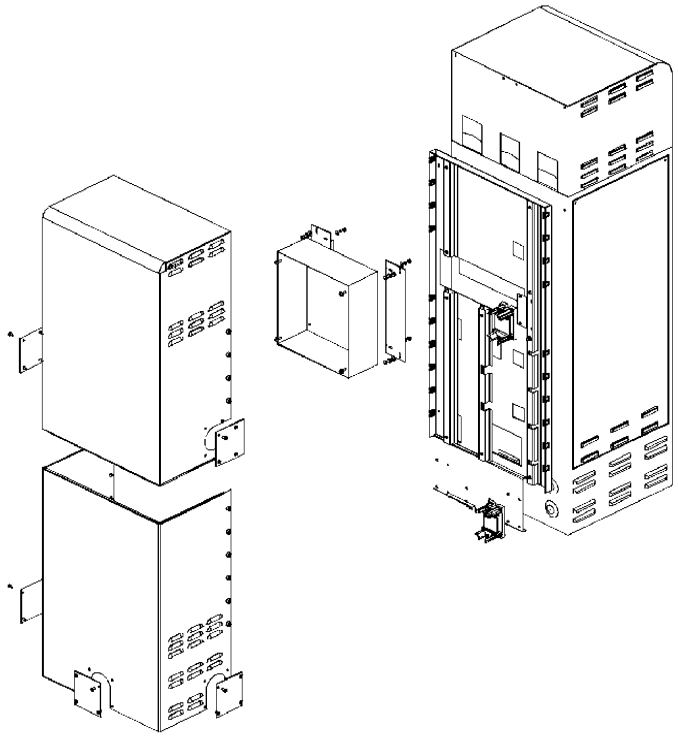
Finishing the Table Installation

Using the procedures in the *EPEX Radiographic Table Service Manual*:

- Place and secure the table
- Install the Tower Assembly

Assembling the Electronics Box on the Generator

Figure 3-11.
Basic Asssembly Diagram of Electronics Box on the Back of the Generator



To assemble the electronics box:

Step	Action
1	Assemble the frame (see Figure 3-12) on the back of the generator cabinet using the four bolts (P/N SCR-00027), lockwashers and flat washers provided and a 4 mm Allen wrench. Thread the upper bolts into the threaded holes in the back of the cabinet. The lower two bolts will require a washer and nut on the backside (inside the cabinet) to secure them. (See Figure 3-13.)

Figure 3-12.
Electronics Box Frame

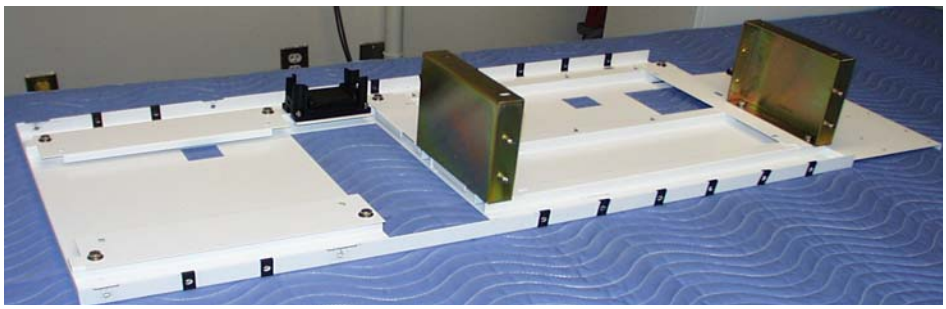
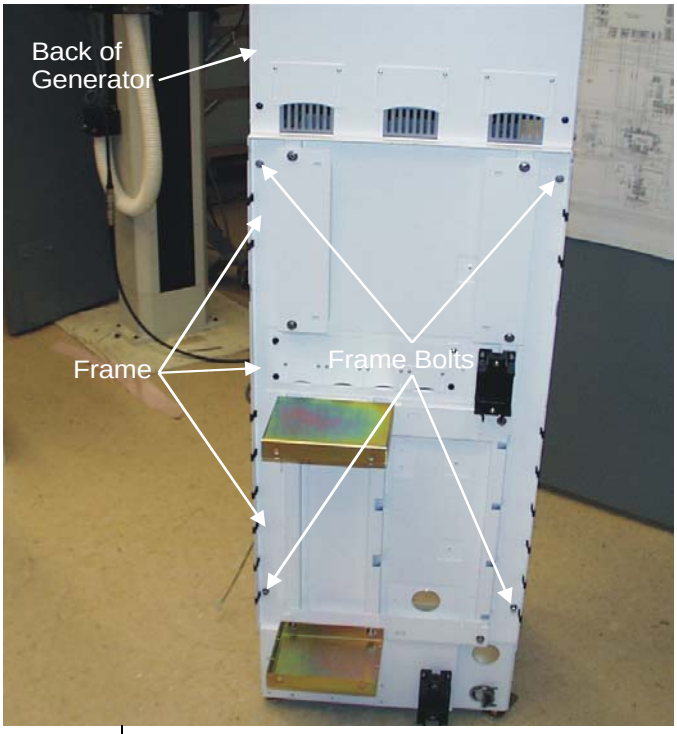


Figure 3-13.
Attaching the Frame

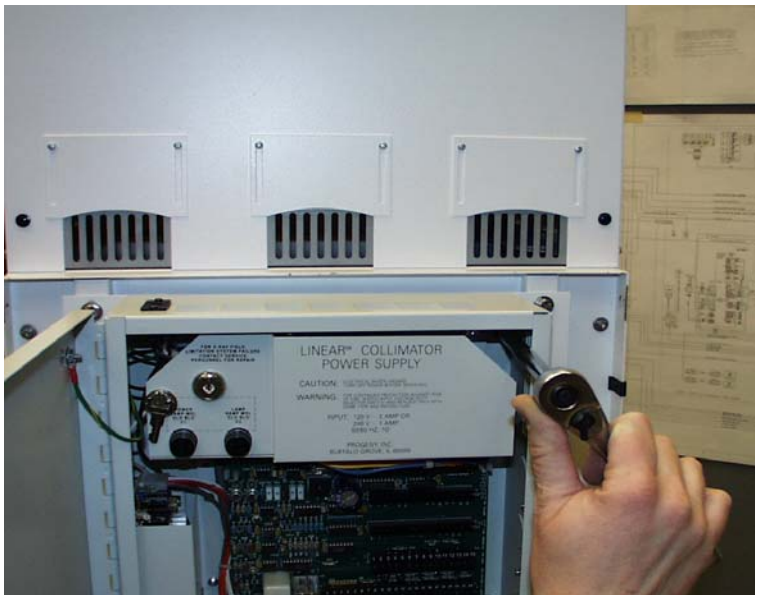


2	Align the collimator supply on the brackets at the top part of the electronics box bracket (see Figure 3-14).

Figure 3-14.
Locating the Collimator
Power Supply Box

3 With the 7/16” socket, ratchet, extender, along with the four bolts (P/N 200-0045), flat washers and lockwashers provided, attach the power supply box (Figure 3-15).

Figure 3-15.
Attaching the Collimator Power Supply Box



4 Attach the key switch (provided with the collimator) to the desired side of the lower back electronics box cover (P/N FAB-00112) with a “ wrench and the attached switch nut (Figure 3-16).

Figure 3-16.
Attaching the key switch to the bottom cover

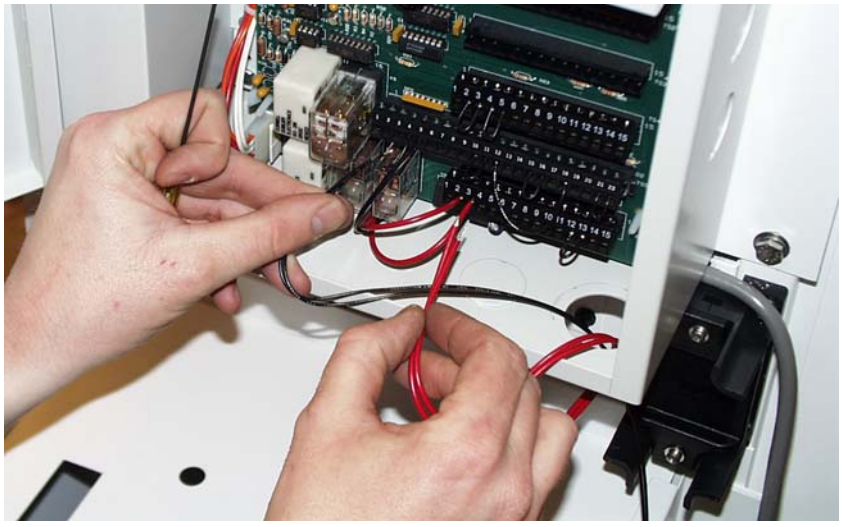
5 Using a Phillips screwdriver and the screws (P/N 200-0029) provided, attach the bottom cover to the generator.

6 Thread the wires from the key switch through the hole in the bottom of the collimator power supply box, as in Figure 3-17.

Figure 3-17. Inserting key switch wires into collimator power supply box

7 Using a small slotted screwdriver, attach the two red wires from the keyswitch to the terminals to which the red wires are attached (numbers 2 and 3) along the bottom row of terminals. Remove the red wires that were previously attached there and tighten the terminal screws (see Figure 3-18).

Figure 3-18. Attaching the wires



8	Attach the two black wires from the keyswitch to the terminals to which the black wires are attached (numbers 4 and 5) along the second row of terminals. Remove the black wires that were previously attached there and tighten the terminal screws.
9	Wrap and tuck the loose wires as necessary to keep them from shorting any of the power supply components or interfering with the operation of the door.
10	When the generator has been cabled appropriately (see next section), install the upper cover of the electronics box with a Phillips screwdriver and the screws (P/N 200-0029) provided.

Cabling the EPEX/Omniflex IV System

For the electrical wiring connections for the EPEX/Omniflex IV System, refer to the Interconnect Diagram in Appendix E. Use it as a reference during the installation process.

Cable routing both inside and outside the Generator cabinet can have a major impact on electrical noise interference. Internally, it is important to ensure the signal cables connecting to the System Controller (E1B1) are routed and exit the cabinet as close to the left side (and as far away from the Inverters) as possible. Externally, route signal cables in conduits separate from the high voltage, stator, and three phase power (mains) cables. If separate conduits are not possible, separate the signal cables using metal dividers in the cable troughs.

All excess cable connecting to the console should be collected in the control room. This minimizes electrical noise pickup from other wiring in the conduits or cable troughs.

CAUTION

To prevent line interference, verify that the high voltage cables and the stator cable are run in conduits or troughs separate from the control and signal cables.

WARNING

Do *not* turn the main disconnect switch on the circuit breaker box ON until all units are connected and ready for the calibration/functional validation procedures.

To cable the EPEX/Omniflex IV System:

Step	Action
1	Verify that the mains input power circuit breaker is OFF.
2	Verify that the RED wire connected between E10 and E11 for 480 Vac systems. ***Note:*** *Wire is located on top left corner of Drive Aux Supply PCB on back wall of top cabinet.*
3	Verify Generator CPU circuit board jumper positions JW2: 2 to 3, JW3: 2 to 3 and JW5: 1-2. ***Note:*** *On the Generator Interface board, JW9 is in 2 to 3 position.*
4	Loosen, but do not remove, the HV transformer vent screw.
5	Verify the mA test jumper is in place. ***Note:*** *The cable access plates are on the rear top and mid-section of Generator cabinet.*

Step	Action
6	Route and connect the HV cables and grounds into the HV transformer in the bottom cabinet, ensuring anode and cathode are properly polarized with the X-ray tube. ***Note:*** *Cables should be started at the OTC and worked backwards towards the Generator.*
7	Connect Power Supply cable (PN 180-0507) from the OTC to the Power Distribution PCB in lower section of Generator cabinet. L = brown N = blue Grn/Yel = Gnd Refer to Appendix E for all system interconnections.

Cable Connections

For the overall cabling connections for the EPEX/Omniflex IV System components, refer to the wiring diagrams in Appendix E.

Cabling the Generator

To cable the Generator:

Connect the input power (nominally 480 VAC, 3-phase) to the input terminal block in the generator. Refer to the generator service manual for more specific instructions.

X-ray Tube Housing Ground

Refer to the generator service manual for specific instructions on grounding the x-ray tube housing to the generator.

Failure to make this ground connection may result in intermittent operation and/or exposure errors.

Wiring the Generator Cabinet Ground

To wire the cabinet ground:

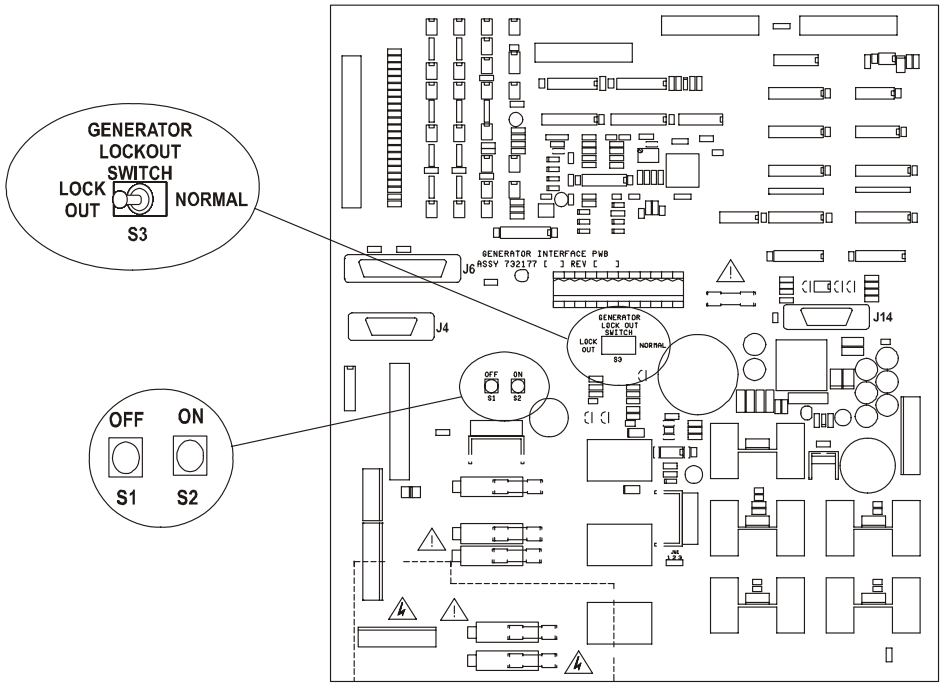
Refer to the generator service manual for specific instructions on wiring the cabinet ground.

Generator Lockout Switch

A safety lockout switch (S3) is provided on the Generator interface board. When this switch is in the LOCKOUT position, the Generator cannot be switched on either from the console or from the adjacent service switch S2 on the Generator interface board. This prevents inadvertently switching on the Generator while it is being serviced.

S3, the Generator lockout switch, must be in the NORMAL position to enable switching the Generator on. For these switch locations, refer to Figure 3-19.

Figure 3-19.
Location of Lockout Switch and Local ON/ OFF Switches



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Safety Interlocks

It is strongly recommended that the door interlock be wired to the Generator before preparing to make any exposures:

Door Interlock

The room door interlock switch must be wired to TB4-11 and TB4-12 on the room Interface board. This switch will provide a closed contact when the door is closed. If no interlock is available, these pins must be jumpered.

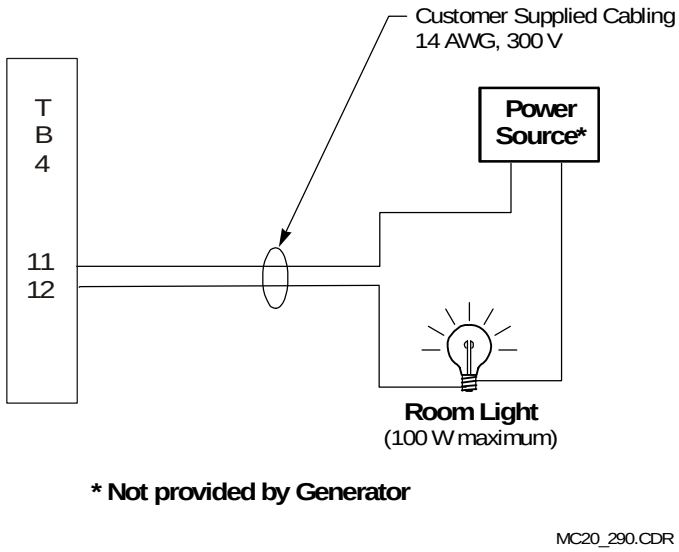
Cable the X-ray Room Warning Light for Power

Incoming power for the X-ray room warning light is through the Generator.

To install the power to the warning light:

Step	Action
1	Verify that the X-ray room warning light and its power cable have been installed by the customer.
2	Check the circuit breaker box and ensure that the power is turned OFF.
3	Check the power cable from the X-ray room warning light according to Figure 3-20.
4	Install the power cable to TB4-11 and TB4-12 of the room interface PCB. Refer to Figure 3-20.

Figure 3-20. Room Warning Light Warning



Excess Cabling

All cables that interface from the Generator to the room equipment should be cut to the correct length, if possible. Excess lengths of cables may contribute to EMI/RFI problems and, as such, should be avoided. If it is not possible to trim the cables to the correct length for the installation (HT cables and console cable for example), try to minimize the area inside any loops of the excess cables as these loops are in effect an antenna. Keep this excess cabling away from sensitive electronic equipment. **Excess cabling must never be bundled up and stored inside the Generator.**

Review the installation at this time to ensure compliance to this requirement.

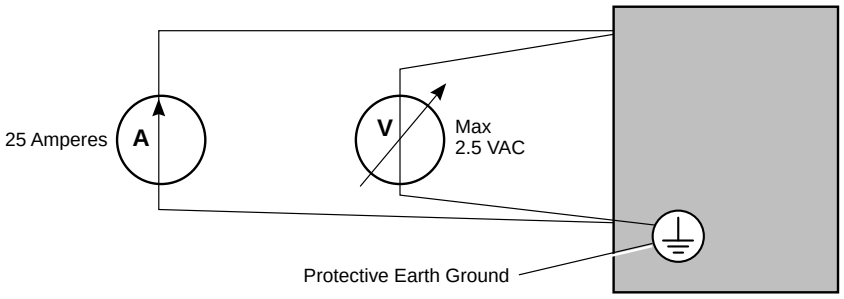
Verify Protective Earth Ground

The protective earth ground test is conducted to confirm the integrity of the protective earth ground (safety ground) connections. This test is conducted pursuant to IEC 601-1 standards, and must be performed at installation.

A current of 25 A, 50 or 60 Hz, is applied to any surface accessible to the operator or patient for at least five seconds. The no load voltage may not exceed 6 V. Refer to Figure 3-21.

Measure the voltage between the point of contact and the protective earth ground. The resultant voltage may not exceed 2.5 Vac.

Figure 3-21.
Protective Earth Ground Test Equipment Configuration



Checks Before Power Up

Check the incoming power line at the Generator for proper phase using the Phase Sequence tester. Correct if necessary.

Tighten the screws securing incoming power to fuses.

Initial Voltage Measurements

To perform the initial voltage measurements:

Step	Action
1	Verify that the mains voltage and current capacity is correct for the Generator installation. Refer to the product ID label on the Generator cabinet and Chapter 1, Section C of the CPI manual shipped with the unit.
2	Temporarily remove the safety cover over the main input fuses in the Generator.
3	If the mains supply is compatible with the Generator, switch on the main breaker and/or disconnect switch. ***Note:*** *Do not switch the Generator on at this time (only the ac mains to the Generator is to be switched on at this time).*

WARNING

Use extreme care in measuring these voltages. Accidental contact with mains voltages may cause serious injury or death.

Mains voltage will be present inside the Generator cabinet, even with the console switched off.

The bus capacitors, located on the base of the power supply, present a safety hazard for a minimum of 5 minutes after the power has been removed from the unit. Check that these capacitors are discharged before touching any parts.

Step	Action
4	Verify that voltage at the main line fuses is at least 389 VAC. If it isn't, then refer to the Three Phase Primary Tap section in your generator service manual for direction.
5	Measure the line voltage across F4 and F6 on the driver/ auxiliary board in the HF power supply. Record the result. ***Note:*** *These fuses are located to the left of the main power supply ground on the large circuit board.*
6	Verify that this voltage is 400 Vac ±10%. ***If the voltage meets the requirement,*** write your initials on the form. ***If the voltage does not meet the requirement,*** the problem must be fixed before you continue with this procedure.
7	Switch OFF the mains power to the Generator.
8	Verify that there is no voltage present across any of the mains input phases. ***If there is no voltage present across any of the mains input phases,*** write your initials on form. ***If there is voltage present across any of the mains input phases,*** the problem must be fixed before you continue with this procedure.
9	Replace the safety cover on the main input fuse block.
10	Switch ON the mains and Generator.
11	Verify that the red LED (DS1) located near the center of the Generator interface board is lit. ***If the LED is lit,*** write your initials on the form. ***If the LED is not lit,*** the problem must be fixed before you continue with this procedure.

Initial Volt Measurement

Main Line Fuse Voltage

	Vac
L1 phase to L 2 phase	
L1 phase to L 3 phase	
L 2 phase to L 3 phase	

Driver/Auxiliary Board Voltage

	Vac
F4 to F6	
	Inital
Verify that the voltage is 400 Vac	
Verify there is no voltage present across any main input phases	
Verify that the red LED (Ds1) is lit	

Pass: _____

Checks After Power Up

Turn on the 3-phase 480 Vac to the Generator cabinet at the wall circuit breaker. Verify LED lights on center of Generator I/O board are on. Check with voltmeter for 230 Vac across brown and blue wires on the Power Distribution board. Power down main breaker and then reconnect cables.

Initial Power Up

WARNING

Hazardous voltages are present throughout the system. High voltage can cause severe injury. Do not open or remove covers when power is applied to the Generator. If any panel, cover, or guard must be removed for an electrical adjustment or check, extreme caution should be exercised to prevent personal injury. Wear insulated gloves when access to energized components becomes necessary.

To perform the initial power up:

Step	Action
1	Apply power to the DirectRay Console UPS and DirectRay Controller CPU.
2	Press the Generator power on button on DirectRay Console and verify (after 60 seconds) that Generator CPU is alive (LEDs).
3	After the DirectRay Controller self-test, wait until the green temperature readout displays on the monitor and then press the DirectRay Console power-up softkey.
4	Verify the grid present LED is lit on the Bucky casting.
5	Verify the grid oscillation with service test pushbutton on L/F Bucky control board.
6	Enter patient applications and verify proper Generator and portrait/landscape communications.

Step	Action
7	Verify the following mechanical functions: • OTC movement • Bucky arm movement • Bucky movement • Table movement • Tower rotation • Lateral Tower/Bucky movement • Check all locks and brakes
8	Verify portrait/landscape rotation is detected at the DirectRay Console and Collimator.
9	Check that the Collimator is registering the correct distance.
10	Configure and acquire low-technique exposure and verify image preview.

Verify Room Warning Light

If the room warning light has been installed and wired, verify that the Warning Light turns on when the **PREP** position of the handswitch is engaged and stays on for the duration of any and all radiographic exposures until the **PREP** position is disengaged.

Completing the EPEX/Omniflex IV System Installation

After equipment installation is complete, the following actions must be taken:

- Adjust and calibrate the system. Refer to Chapter 4.
- Configure the system. Refer to Chapter 4 in the *DirectRay Console Service Manual*.
- Configure the DirectRay Console application. Refer to Chapter 5 in the *DirectRay Console Service Manual*.
- Complete system acceptance. Refer to the *DirectRay System Acceptance Manual*.
- Complete final assembly. Refer to the following procedure.

Final Assembly

The final assembly consists of the following:

Step	Action
1	Bolt/anchor Generator to the floor.
2	Verify all connections.
3	Replace all covers.
4	Clean all equipment.
5	Verify that the fan is operational.
6	Touch up paint where necessary.
7	Verify system configuration.

Chapter 4
Adjustments and Calibration

This chapter provides the procedures required to adjust and calibrate the EPEX/Omniflex IV System. Adjustments may be required to fine tune the system after the initial installation or if components have been replaced.

The calibration procedures assume that the system configuration setting for the X-ray Generator were factory set so additional adjustments required will be minimal to calibrate the system.

Forms to record the calibration and site settings are provided in Appendix C. Keep a copy of these records on site, and send the originals back to the Installation Coordinator at Del.

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Connecting the Service Laptop

Installing the GenWare Console Program

The minimum requirements for running the GenWare Console are a 486-based computer capable of running Windows 3.1 or higher with at least 8 MB of RAM and 40 MB of free hard drive space. It should be noted that fulfilling the minimum requirements does not necessarily mean that the program will function at a satisfactory speed.

To install GenWare Console, insert the first of the three disks into the drive and run a:\setup from within Windows. Be sure to have all other applications closed before starting the installation. After the installation has begun, follow the instructions on the screen.

Connecting the computer to the console unit is done using a standard null modem cable. The cable is connected to the serial port on the computer and the 9-pin port (J11) of the Generator CPU board.

Starting GenWare Console

To begin the program, double-click the GenWare Generator Utilities icon found in the GenWare Utilities program group. Following the momentary appearance of a splash screen, the main window of the utility displays.

Setting the Communications Link

To setup the GenWare console to communicate with the console, it must know which communications port (commonly known as the ‘Com’ port) the data is being transferred through. This can be changed by clicking the com port settings button which is the icon at the right-most side of the toolbar. A window containing port settings displays.

For the 1.3 version of the GenWare Generator Utilities software, only the com port can be changed.

Connect the Console Adaptor Cable from the com port on the computer to the nine pin interface on the console. Place the console unit into a data wait mode. Enter the programming mode of the console (this requires a password). Press the data link button. The console displays the message ‘waiting for data’ and is ready to receive commands.

Setting the Generator Utilities

Utility Menu

The Utility menu displays the following options:

- Setting Time and Date
- Error Log
- Statistics
- Console

Setting Time and Date

To set the time and date:

Step	Action
1	From the **Utility** menu, choose **Set Time & Date**.
2	To set the year, choose **Year** and press the + or – buttons.
3	To set the month, choose **Month** and press the + or – buttons.
4	To set the day, choose **Day** and press the + or – buttons.
5	To set the hour, choose **Hour** and press the + or – buttons.
6	To set the minutes, choose **Min** and press the + or – buttons.
7	To return to the Utility menu, choose **Exit**.
8	To return to the Generator Setup menu if you have no further changes to make, choose **Exit** again.

Error Log

The ERROR LOG menu allows you to review the error messages stored in the Generator's error log. Parameters such as kV, mA, time, receptor, focus, tech selection, field, film screen, and fluoro parameters are displayed simultaneously on the console LED displays.

Step	Action
1	From the Utility menu, choose **Error Log**.
2	To scroll through the error log, choose **Error #** and press the + or – buttons.
3	To return to the Utility menu, choose **Exit**.
4	To return to the Generator Setup menu if you have no further changes to make, choose **Exit** again.

Statistics

The Statistics menu shows the tube exposure count, accumulated fluoro hours if applicable, and the accumulated Generator exposure count. You can reset counters from this screen.

Step	Action
1	From the Utility menu, choose **Statistics**.
2	To reset the tube exposure counter, choose **Reset Tube 1 Exp**.
3	To reset the fluoro exposure counter, choose **Reset Fluoro Hours**.
4	To return to the Utility menu, choose **Exit**.
5	To return to the Generator Setup menu if you have no further changes to make, choose **Exit** again.

Generator Setup Menu

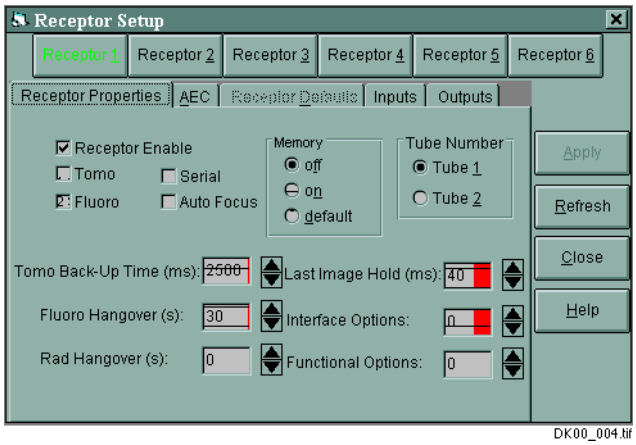
Receptor 1 Setup

Note: *Do not use the default settings.*

The Receptor Setup menus allow each of the image receptors to be programmed as defined in the following table.

Receptor Properties Menu Tab	Name	Receptor 1 Setup
	Receptor Number	1
1	Receptor Enable	On
2	Tomo Enabled	Off
3	Fluoro Enabled	Off
4	Serial Enabled	Off
5	Auto Focus	Off
6	Memory	Off
7	Tube	1
8	Tomo Back-Up Time	2500
9	Fluoro Hangover	30
10	Rad Hangover	0
11	Last Image Hold (ms)	40
12	Interface Options	0
13	Functional Options	None

The following is an example Receptor 1 Setup screen.



Term	Definition
Tomo	Enables or disables tomographic operation
Fluoro	Enables or disables fluoroscopic operation
Serial	Allows repeated (serial) X-ray exposures without the need to re-prep after each exposure. Normally used with serial film changers (NO is disabled).
Memory	Defines the default techniques when a receptor is chosen: **YES:** The chosen receptor remembers its last techniques. These techniques are displayed when that receptor is re-chosen. **NO:** The chosen receptor does not remember the last techniques used on that receptor. The techniques default to the last used on the previous receptor. **DEF:** The techniques used for that receptor are programmed. Refer to Receptor Setup menu 4 and 5.
Fluoro Hang	Sets the time that the rotor will continue spinning after a fluoro exposure has terminated.
RAD Hang	Sets the time that the rotor will continue spinning after a rad exposure has terminated.
Last Image Hold	Sets the time that the exposure will continue after the fluoro footswitch has been released. This enables a frame store device to complete the last image.

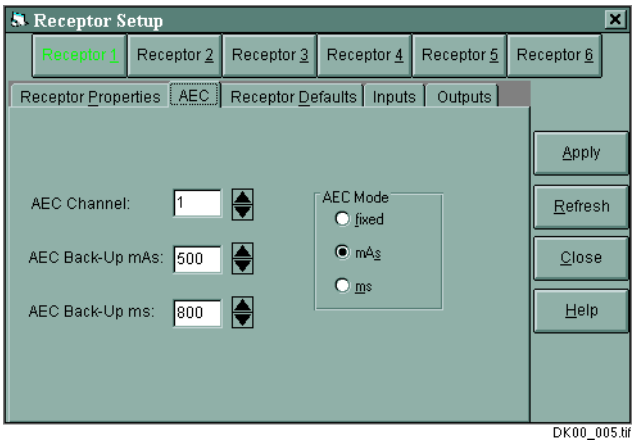
Term	Definition
Interface Opts	Selects pre-defined interface options: 0 = None 1 = InfiMed digital 2 = ATS ESI digital 3 = Gilardoni digital pulsed RAD 4 = Gilardoni digital HCF 5 = Not assigned at this time
Tube	Selects the tube assigned to that receptor.
Receptor Sym	Allows one of six receptor symbols [sym] to be associated with the selected receptor. Symbol 7 is blank and may be used for an auxiliary device.

It is recommended that the Image Receptor Programming be backed up on the GenWare software. Access the utility section and request the Generator Installation report. A copy of the report must be sent to the Installation Coordinator and an additional copy printed and filed on site.

AEC Setup

The AEC Setup menu allows you to set the AEC parameters for each AEC channel.

The following is an example AEC setup screen.



Parameter	Definition
AEC Channel	Defines which AEC channel used by the receptor. This must be set to a valid channel or 0 as noted below. For example, if using an AEC board with only 3 input channels (channels 1 to 3) then selecting AEC channel 4 will cause an error. Selecting 0 disables AEC operation on that receptor. The default setting is 1.
AEC Back-Up mAs	Sets the maximum backup mAs, to a limit of 500 mAs. The default setting is 500.
AEC Back-Up ms	Sets the maximum backup ms. The default setting is 800.
AEC Back-Up Mode	Defines the AEC backup mode to be used: **FIXED:** The Generator will determine the maximum AEC backup time, not to exceed preset AEC backup mAs/ms values or system limits. The characters **AEC** will be displayed in the time window of the LED display during AEC operation. **mAs:** Allows the operator to adjust the AEC backup mAs, not to exceed preset AEC backup mAs/ms values or system limits. The mAs value will be displayed in the time window of the LED display during AEC operation. **ms:** Allows the operator to adjust the AEC backup ms, not to exceed preset AEC backup mAs/ms values or system limits. The ms value will be displayed in the time window of the LED display during AEC operation. The default setting is 1.

Receptor Defaults

This selection is available only if Memory was set to DEF in the Receptor Setup menu 2.

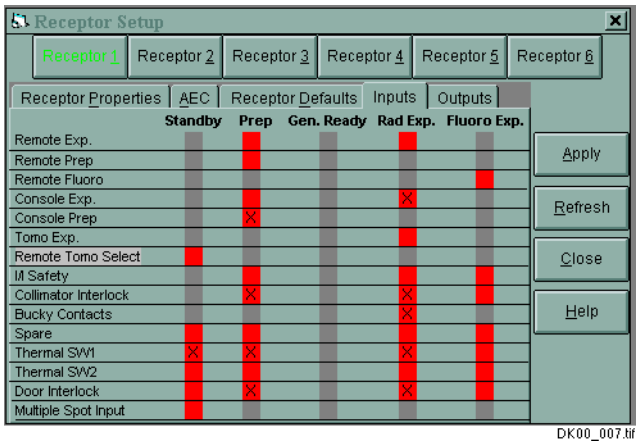
Parameter	Definition
Technique	mAs
Default Focus	Large
Default Density	0
Default Film Screen	1
Default Fields	RCL
Default Voltage (kV)	75
Default Current (mA)	200
Default Time (ms)	200

I/O Configuration

The I/O Configuration menus allow programming of the states of exposure for the inputs and the outputs on the Room Interface board.

Input Menu Tab	Standby	Prep	Gen Ready	Rad Exp
Remote Exposure	Off	Off	Off	On
Remote Prep	Off	Off	Off	Off
Rem. Fluoro Exp	Off	Off	Off	Off
Console Exposure	Off	Off	Off	On
Console Prep	Off	On	Off	Off
Tomo Exposure	Off	Off	Off	Off
Remote Tomo Select	Off	Off	Off	Off
I.I Safety	Off	Off	Off	Off
Collimator Interlock	Off	On	Off	On
Bucky Contacts	Off	Off	Off	On
Spare	Off	Off	Off	Off
Thermal Switch 1	On	On	Off	On
Thermal Switch 2	Off	Off	Off	Off
Room Door Interlock (if applicable)	Off	On	Off	On
Multiple Spot Exposure	Off	Off	Off	Off

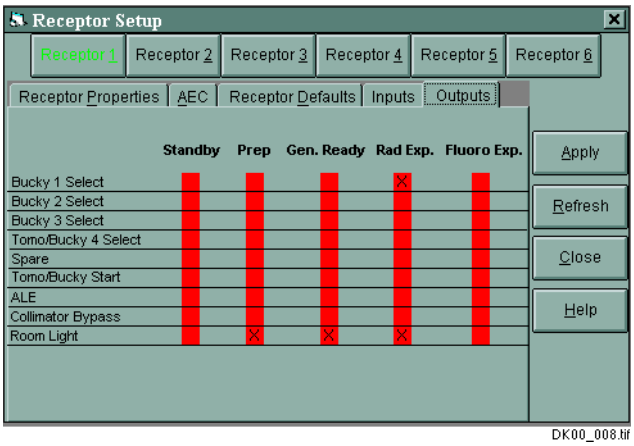
The following is an example of the Inputs screen.



The set-up outputs are described in the following table.

Output Menu Tab	Standby	Prep	Gen Ready	Rad Exp	Fluoro
Bucky 1 Select	Off	Off	Off	On	N/A
Bucky 2 Select	Off	Off	Off	Off	Off
Bucky 3 Select	Off	Off	Off	Off	Off
Tomo/Bucky 4 Select	Off	Off	Off	Off	Off
Spare	Off	Off	Off	Off	Off
Tomo Bucky Start	Off	Off	Off	Off	Off
ALE	Off	Off	Off	Off	Off
Collimator Bypass	Off	Off	Off	Off	Off
Room Light	Off	On	On	On	Off

The following is an example of the Outputs screen.



The grey stripes mean that the function is not enabled/inactive. The red stripes mean that the function is enabled/active.

The arrow in the lower middle area points to one of the five states described below. Moving to the next state is accomplished by pressing the **State** button. The states are described in the following table.

State	Description
STANDBY	Sets state of the I/O when the Generator is in standby or idle mode. Standby mode also defines the state when the Generator is in fluoroscopic hangover.
PREP	Sets state of the I/O when the Generator first enters PREP mode.
GEN RDY	Sets state of the I/O when the Generator has completed PREP mode and is ready to expose.
RAD EXP	Sets state of the I/O when the Generator starts a radiographic exposure.
FLUORO EXP	Sets state of the I/O when the Generator starts a fluoroscopic exposure.

AEC Density Calibration

Verify density settings using the GenWare software. If the values are incorrect, reenter the correct values in the blocks as described in the following table.

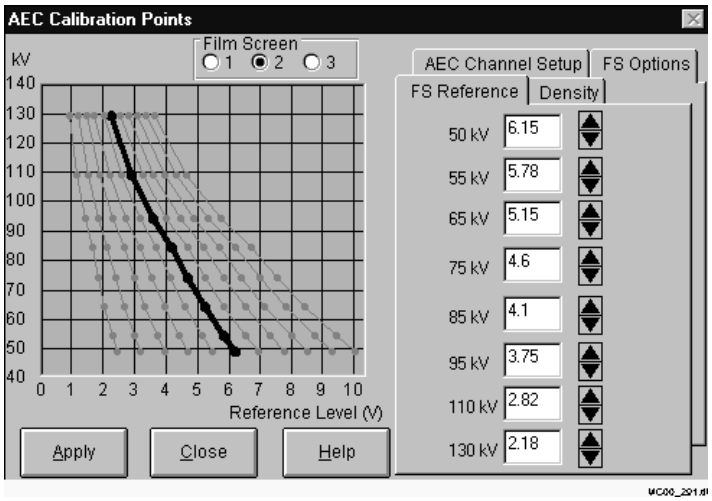
	AEC Density
-8 Density	0
-7 Density	0
-6 Density	0
-5 Density	62
-4 Density	50
-3 Density	37
-2 Density	25
-1 Density	12
1 Density	12
2 Density	25
3 Density	37
4 Density	50
5 Density	62
6 Density	0
7 Density	0
8 Density	0

AEC Setup

The following table defines the AEC setup parameters.

Parameter	Definition
Channel	Selects the AEC channel to be programmed.
Left Field	Enables or disables the left field for the selected AEC channel (**NO** is disabled).
Center Field	Enables or disables the center field for the selected AEC channel (**NO** is disabled).
Right Field	Enables or disables the right field for the selected AEC channel (**NO** is disabled).
Chamber Type	Selects Ion Chamber or Solid State (S/S) chamber for the selected AEC channel.
Film Screen 1	Enables or disables the selection of Film Screen 1 for that AEC channel (**NO** is disabled).
Film Screen 2	Enables or disables the selection of Film Screen 2 for that AEC channel (**NO** is disabled).
Film Screen 3	Enables or disables the selection of Film Screen 3 for that AEC channel (**NO** is disabled).

Adjust the FS reference values for each kV in Film Screen 1, 2, and 3 according to the table shown below.



kV	50	55	65	75	85	95	110	120
Value	6.15	5.78	5.15	4.60	4.10	3.75	2.82	2.18

Click on the FS option menu tab and ensure the values are:

RLF Compensation at 50 ms: 0

RLF Compensation at 500 ms: 0

RLF Compensation at 1000 ms: 0

Multiple Spot Compensation: 0

Adjust as required.

X-ray Tube Calibrations

Prior to beginning tube auto-calibration, the tube used in this installation must be properly selected, and the Generator limits should be programmed. Refer to the procedures in the topic “Generator Setup Menu” on page 4-5.

It is recommended that the replacement tube(s) be conditioned (seasoned) before beginning tube auto-calibration, refer to the first procedure in this topic.

WARNING

The following procedure produces X-rays. Take all safety precautions to protect personnel from X-radiation.

CAUTION

Always verify the manufacturer of the tube insert. If the X-ray tube has been rebuilt, the tube insert and tube housing may be different manufacturers.

CAUTION

Collimator blades must be closed and lead apron applied to the tube before starting the tube calibration.

Conditioning the X-ray Tube

Tube conditioning or “seasoning” is particularly important for new tubes or tubes that have not been used for several days. This should be performed on each X-ray tube before attempting auto-calibration, as an unseasoned tube may not operate properly at higher kV values without arcing. Refer to the X-ray tube manufacturer’s instructions, if available, for the tube conditioning or “seasoning” procedure. If the X-ray tube manufacturers instructions are not available, use the procedure in this topic.

The Generator does X-ray tube auto-calibration at 50 kV, 60 kV, 70 kV, 80 kV, 100 kV, and 120 kV. The tube normally needs to be seasoned before it can be operated at the higher voltages encountered during auto-calibration.

With the GenWare utility, tube seasoning is started by auto-calibrating the kV stations up to and including part of the 70 kV station. The tube is then seasoned at 70 kV. Progressively higher kV stations are then auto-calibrated and seasoned. Finally the entire kV and mA range is auto-calibrated, then the tube is seasoned at the remaining high kV values.

Manually releasing the exposure button during auto-calibration of a particular kV station in the following procedure prevents the Generator from attempting operation beyond that kV/mA value.

Note: *Only low speed exposures are recommended for the seasoning exposures, to prevent excessive heat build-up in the housing from the stator windings or the rotor bearings.*

X-ray tubes that have not been used for more than 8 hours may suffer thermal shock if operated at high mA and kV without a warm-up procedure. A cold anode (Molybdenum) is very brittle and when suddenly heated over a small area may experience thermal cracking of the anode surface, eventually leading to permanent tube damage.

The procedure below is intended for seasoning an X-ray tube prior to attempting tube auto-calibration. To season a tube that does not need to be calibrated, simply follow steps 2, 4, 6, 8, and 9.

To condition a X-ray tube:

Step	Action
1	Start the tube auto-calibration sequence, and manually terminate the exposure at 70 kV and 250 mA.
2	Season the tube at 70 kV by taking approximately 10 exposures of 200 mA and 100 ms. These exposures should be taken at the rate of approximately one every 15 seconds.
3	Restart the auto-calibration sequence and manually terminate the exposure at 100 kV and 250 mA.
4	Season the tube at 100 kV by taking approximately 5 exposures of 200 mA and 100 ms. These exposures should be taken at the rate of approximately one every 15 seconds.
5	Restart the auto-calibration sequence and manually terminate the exposure at 120 kV and 160 mA.
6	Season the tube at 120 kV by taking approximately 5 exposures of 160 mA and 100 ms. These exposures should be taken at the rate of approximately one every 15 seconds.
7	Restart the auto-calibration sequence and allow the auto-calibration sequence to complete.
8	Season the tube at 130 kV by taking approximately 5 exposures of 100 mA and 50 ms. These exposures should be taken at the rate of approximately one every 15 seconds.
9	Repeat step 8 at 140 kV, and then at 145 kV.
10	Allow the tube to cool down for approximately 15 minutes before taking more exposures.

X-ray Tube Warm Up

Note: *This procedure can be skipped if the tube conditioning or seasoning has taken place within two hours, if the heat unit display is 0 or the system has not been used recently.*

Before subjecting any X-ray tube to radiographic kVp or mA loading, the tube must be warmed up to prevent possible arcing. Operating the tube at low mA and gradually increasing the kV seasons the tube and might reveal a faulty X-ray tube high tension cable.

CAUTION

To prevent damage to the X-ray tube, ensure the tube is warmed to 7 to 9% heat units, prior to use.

Perform the tube warm up procedure from the application software screen. (see the Operator Console Service Manual or User's Guide for exact details and images of the software screen)

X-ray Tube Calibration Procedure

Note: *Should an error occur during auto-calibration, an error message displays. The Generator limits the tube's operation to the range in which it was calibrated, thus allowing for partial operation of the Generator. When you reenter auto-calibration, the tube calibration resumes from where the error occurred.*

To calibrate the X-ray tube:

Step	Action
1	Connect the Service laptop to J11 on the CPU board via the null modem cable.
2	From the GenWare Program setup select window, choose **Set up**.
3	Select **Auto Tube Calibration**. The Tube Calibration menu displays.
4	Select tube 1. The Tube Auto-Cal menu displays.
5	Select the small filament. ***Note:*** *Press* ***Focal Spot*** *to toggle between Small and Large.* The small focal spot displays.
6	Press and hold the **X-ray** handswitch to begin the calibration procedure. ***Note:*** *This will take approximately five minutes.* This menu indicates the mA and filament current while the Generator takes a series of exposures.
7	When auto-calibration is complete for the small filament, choose the large filament.
8	Press **Return** to repeat calibration on the large focal spot.

9	When auto-calibration is complete, press **Close** to exit the tube auto-calibration menu. The Generator Utility menu displays.

Collimator System Calibration

System Adjustments and Calibration

In order to correctly set-up and operate the Collimator, it is necessary to adjust all the potentiometers sensing circuits. Refer to the Collimator, Overhead Tube Crane, and Table service manuals for the following setup and calibration procedures.

- Horizontal Leveling for the X-ray Tube
- 0 Degree Rotational Adjustment for the X-ray Tube
- Vertical Drive Chain Adjustment for the OTC
- Horizontal Source Image Distrance (HSID) Adjustment

  Refer to the A, B, and C detent setup drawings in Figure 4-1 on page 4-23, Figure 4-2 on page 4-24, and Figure 4-3 on page 4-25.
- SID Potentiometer Adjustment – Continuous SID Sensing

The position sensing potentiometers must have 1-K Ω resistance and linearity equal or better than 1%.

It is also very important that the potentiometer is used for at least 75% of its total travel (75 Ω for the total travel).

It is not necessary to set the potentiometer in the way that, in a particular position of the movement, the resistance has a particular value; in fact, it is enough that the minimum resistance of the potentiometer is less than 100 Ω.

To correctly position each potentiometer, the following are the minimum resistance positions:

- Tube Vertical Travel: When the tube is in its lower limit stop (close to floor), the resistance must be less than 100 Ω.
- Bucky Vertical Travel: When the Bucky is in its lower limit stop (close to floor), the resistance must be less than 100 Ω.
- Light Field Alignment
- X-ray Tube Travel Limits Initialization
- Manual Mode Vertical Speed Adjustment
- Wall Mode Tracking Calibration
- Auto-mode Vertical Speed Adjustment
- Lower Travel Limit Adjustment
- Table Mode Tracking Calibration
- Upper Travel Limit Adjustment
- X-ray Tube/Bucky Height Differential Reading Calibration
- Collimator Differential Vertical SID Adjustment
- SID Display Calibration

Central Beam and X-ray to Light Field Adjustments

The following adjustments and calibrations must be performed to ensure functionality and conformance with 21CFR.

These procedures should be considered one complete test. It is not recommended that adjustments be made without completing this test in the order it is presented.

The following procedures are included in the test:

- Mechanical Checks before Beam Alignment
- Aligning the Test Tool to DirectRay Detector Center
- Aligning VSID Central Beam to DirectRay Detector Center
- Verifying VSID X-ray Field Centered to DirectRay Detector Center
- Aligning the Collimator Light Field to X-ray Field
- Aligning the Collimator Crosshair to X-ray Field
- Aligning HSID Central Beam and X-ray Field Center to DirectRay Detector Center
- Adjusting the Collimator Blades

Mechanical Checks Before Beam Alignment

To perform the mechanical checks:

Step	Action
1	Determine which detent position (A, B, or C) setup is going to be used for the system. Refer to Figure 4-1 on page 4-23, Figure 4-2 on page 4-24, and Figure 4-3 on page 4-25. ***Note:*** *Actual detent position(s) can be changed to meet grid focus distance or site related requirements. Refer to Table 4-1.*
2	Ensure that the longitudinal rail and transverse bridge are level and the OTC is perpendicular to the rails.
3	Ensure that the table base is level to within 0.2° and parallel to the longitudinal rails (within 1/16 in.).
4	Ensure that the X-ray tube port is level and perpendicular to the ground.
5	Use a calibrated digital level on the X-ray tube port to ensure that the tube is level to within 0.1° or better in the transverse and longitudinal directions.
6	To adjust the tube transverse direction, loosen the trunnion rings and rotate the tube front to back.
7	To adjust the tube longitudinal direction, adjust the tube rotation cam in the rear of the tube head arm.
8	Verify at ±90° rotation of the Y-axis.
9	Verify at ±90° rotation of the Z-axis.

Table 4-1. Detent Position Table

EPEX Detent Position	Grid Focus Distance fo:	HSID1 Measure and set detent to:	HSID2 Measure and set detent to:
A1, B1, C1	100 cm	100 cm or 40 in.	180 cm or 72 in.
A1, B1, C1	140 cm	112 cm or 44 in.	180 cm or 72 in.
A2, B2, C2	140 cm 180 cm	N/A	180 cm or 72 in.
A3, C3	N/A	N/A	N/A

Figure 4-1. Detents for Position A

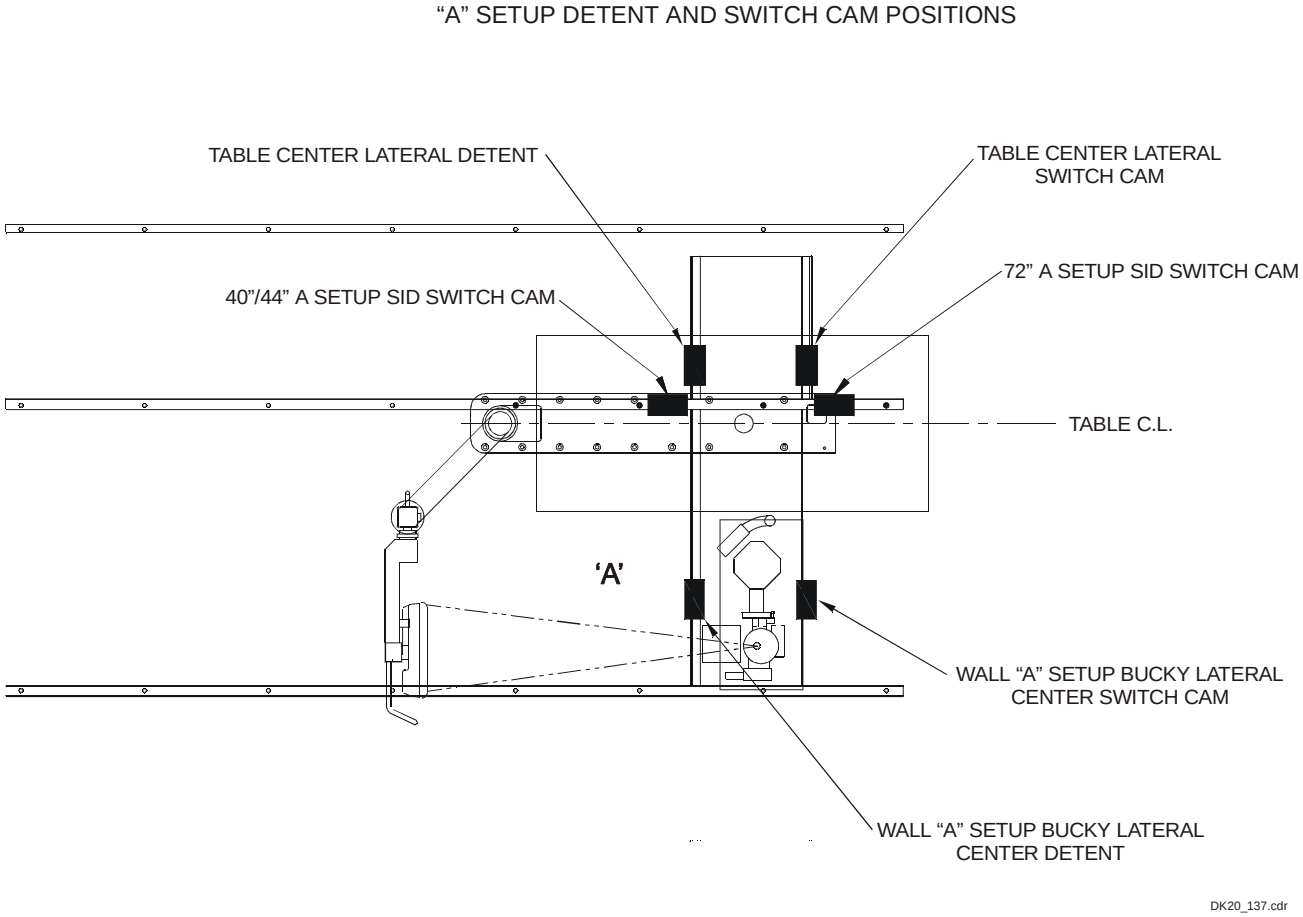

"A" SETUP DETENT AND SWITCH CAM POSITIONS
TABLE CENTER LATERAL DETENT
TABLE CENTER LATERAL SWITCH CAM
72" A SETUP SID SWITCH CAM
40"/44" A SETUP SID SWITCH CAM
TABLE C.L.
'A'
WALL "A" SETUP BUCKY LATERAL CENTER SWITCH CAM
WALL "A" SETUP BUCKY LATERAL CENTER DETENT
DK20_137.cdr

Figure 4-2. Detents for Position B

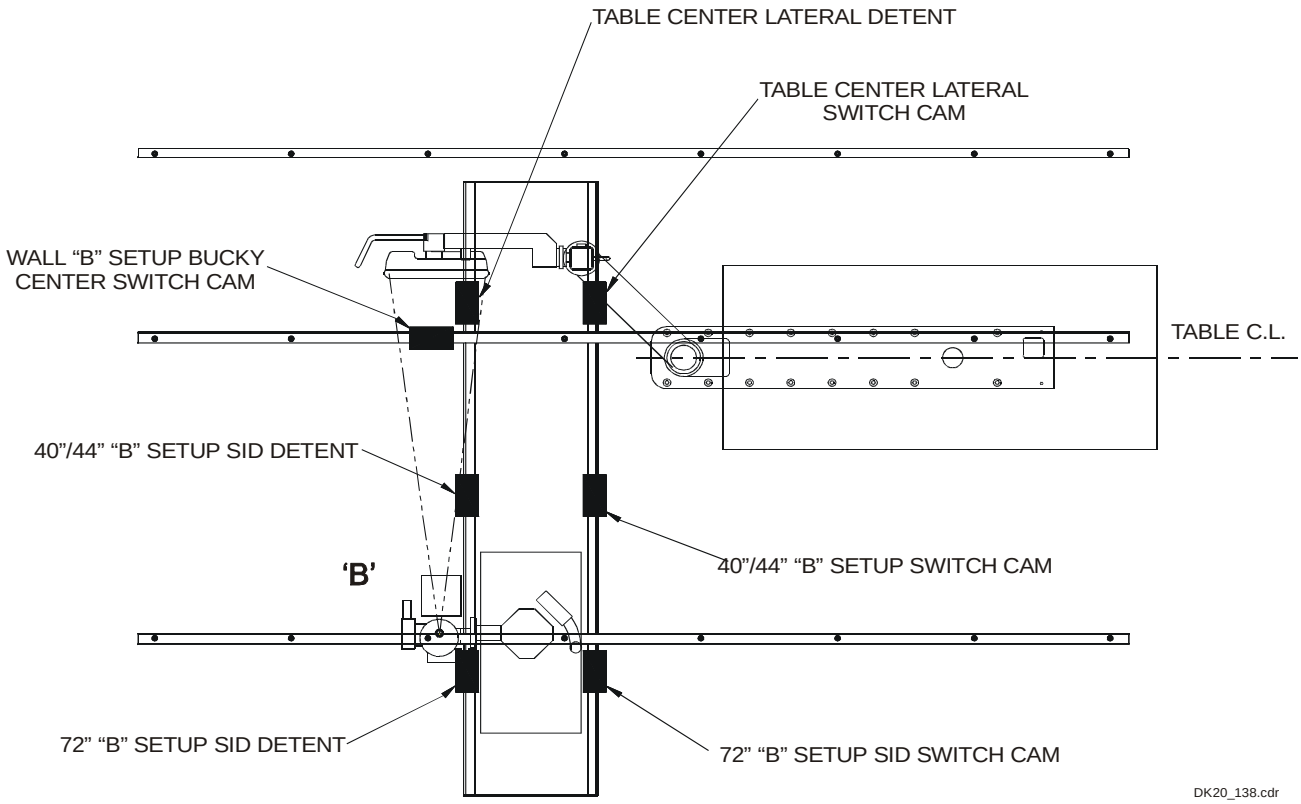
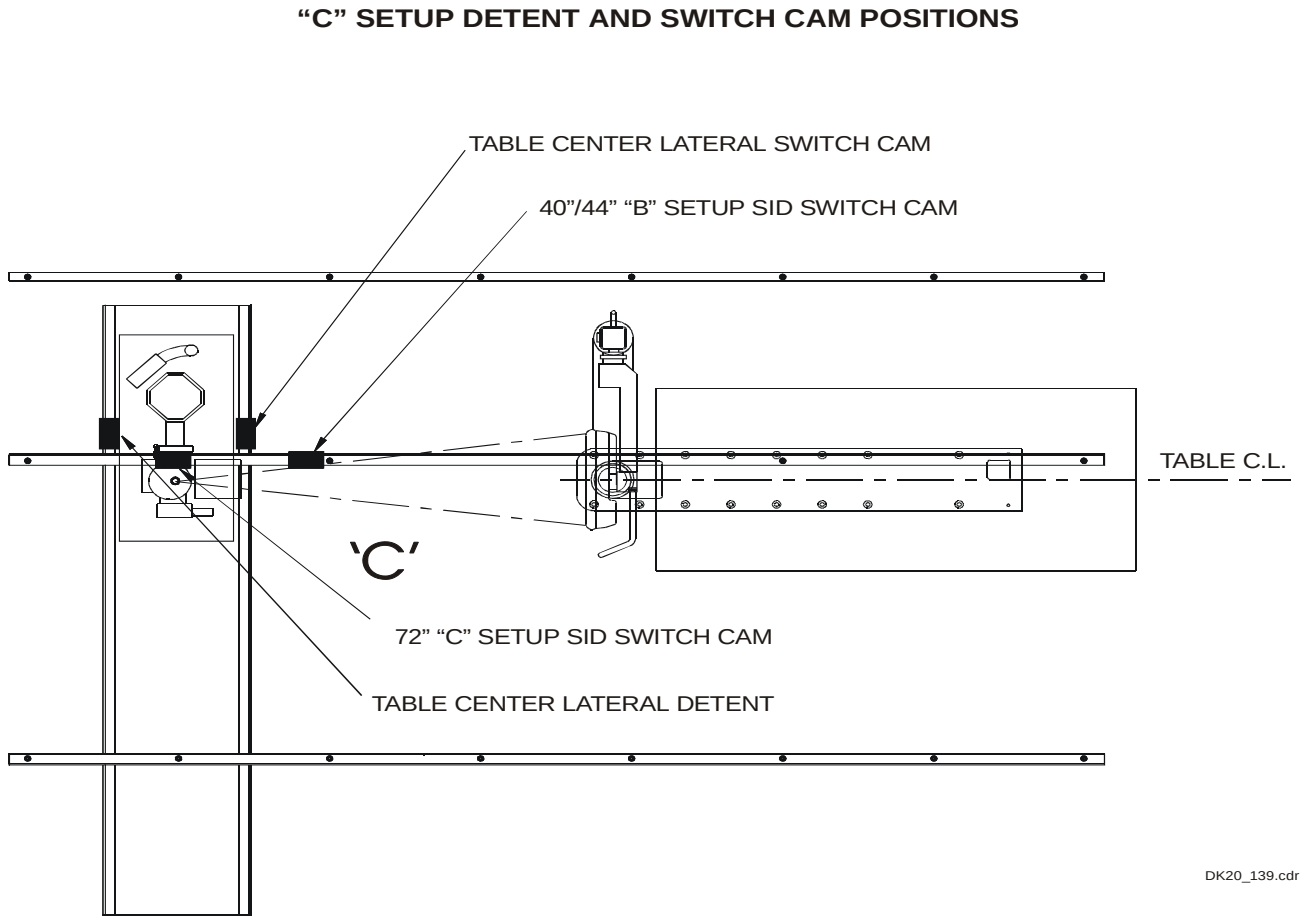

“B” SETUP DETENT AND SWITCH CAM POSITIONS
TABLE CENTER LATERAL DETENT
TABLE CENTER LATERAL SWITCH CAM
WALL “B” SETUP BUCKY CENTER SWITCH CAM
TABLE C.L.
40”/44” “B” SETUP SID DETENT
‘B’
40”/44” “B” SETUP SWITCH CAM
72” “B” SETUP SID DETENT
72” “B” SETUP SID SWITCH CAM
DK20_138.cdr

Figure 4-3. Detents for Position C


“C” SETUP DETENT AND SWITCH CAM POSITIONS
TABLE CENTER LATERAL SWITCH CAM
40”/44” “B” SETUP SID SWITCH CAM
TABLE C.L.
‘C’
72” “C” SETUP SID SWITCH CAM
TABLE CENTER LATERAL DETENT
DK20_139.cdr

Aligning the Test Tool to the DirectRay Detector Center

To align the test tool to the DirectRay Detector center:

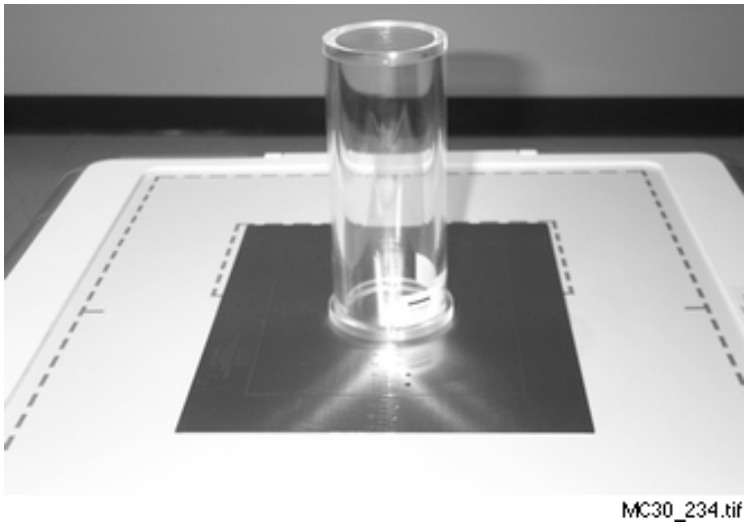
Step	Action
1	In portrait, position the Bucky to table centerline with the Bucky tower carriage in the home position.
2	Place the Collimator test tool in the approximate center of the Bucky.
3	Set SID to 100 cm for fo: 100 cm grids or 112 cm for fo: 140 cm (non-focused) grids.
4	Adjust the Collimator shutters so that the edges of the light field roughly coincide with the rectangular outline on the Collimator tool.
5	Initiate exposure at approximately 60 kVp and 8 mAs.
6	Accept the image in the DR Image Viewer (DRIVEL).
7	Press **Center** to display DirectRay Detector center lines.
8	Reposition the center of the Collimator test tool to be aligned with the DirectRay Detector center (center pixel).
9	Repeat this step until the Collimator test tool is centered with the DirectRay Detector center.
10	Once the Collimator test tool is aligned with the DirectRay Detector center, tape the Collimator test tool in place on the Bucky cover.

Aligning VSID Central Beam to the DirectRay Detector Center

To align the VSID central beam to the DirectRay Detector center:

Step	Action
1	Place the beam alignment tool (Plexiglas cylinder) in the center of the Collimator tool. Refer to Figure 4-4.
2	Place a circular level on top of the beam alignment tool and shim the alignment tool until it is level.

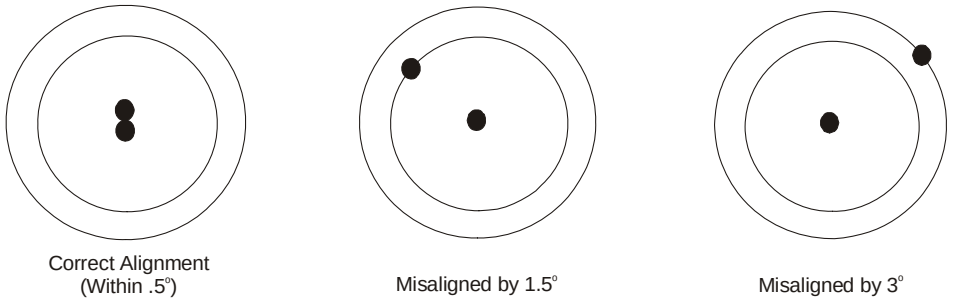
Figure 4-4.
Beam Alignment Tool



Step	Action
3	Adjust the Collimator shutters so that the edges of the light field roughly coincide with the rectangular outline on the Collimator tool.
4	Initiate exposure at approximately 60 kVp and 8 mAs.
5	Accept the image in DRIVEL.
6	Press **Center** to display the DirectRay Detector center lines.
7	Adjust the OTC transverse and longitudinal travel.
8	Repeat exposures until the images of the two beads overlap at the DirectRay Detector center.
9	Use DRIVEL to find the coordinates for relocating the central beam and the center of the Collimator test tool directly over the DirectRay Detector center (center pixel).

Step	Action
10	***If the images of the two beads overlap,*** the central beam is perpendicular to within 0.5°. ***If the image of the larger bead intercepts the first circle,*** the beam is about 1.5° away from perpendicular. Refer to Figure 4-5**.** ***Note:*** *The top hole in the cylinder is slightly larger than the bottom one. It is necessary to move the X-ray tube head in a direction toward the larger spot to align with the smaller.*

Figure 4-5.
Central Beam Alignment



Step	Action
11	Repeat steps 1 to 10 until the two holes are within 0.5°. This position now represents the position of the central beam directly over the DirectRay Detector center.
12	Verify bead overlap is maintained from MIN to MAX VSID. If necessary, interactively adjust the X-ray tube transverse and longitudinal position.
13	Set the transverse center table detent.

Verifying VSID X-ray Field Centered to the DirectRay Detector Center

To verify VSID X-ray field centered to DirectRay Detector center:

Step	Action
1	Using the measure function in DRIVEL, measure from the central beam spot on the beam alignment tool to all four edges of the black X-ray field. ***Note:*** *The central beam should be centered so that the distances to all four sides are equal. It is not necessary at this time to align the X-ray field to the Bucky.*
2	Initiate exposure.
3	Accept the image in DRIVEL.
4	Interactively adjust the location of the X-ray field until it is centered in portrait and landscape. ***Note:*** *21CFR allows a 2% error in this alignment. In order to ensure image quality and correct alignment, it is suggested that a 1% error or better (1 cm total at 100 cm) be achieved.*

Aligning the Collimator Light Field to the X-ray Field

Note: *If the light field to the X-ray is too small, refer to the Collimator service manual that came with the system.*

To align the Collimator light field to the X-ray field:

Step	Action
1	Set SID to 100 cm.
2	Adjust the Collimator shutters so that the edges of the light field coincide with the rectangular outline of the Collimator test tool. ***Note:*** *Ignore the Collimator crosshair.*
3	Initiate an exposure at approximately 60 kVp and 8 mAs.
4	Accept the image.
5	View the image in DRIVEL. ***If the X-ray field falls just within the image of the rectangular frame,*** there is good alignment. Refer to Figure 4-6. ***If an edge of the X-ray field falls on the first spot, ±1 cm on either side of the line,*** the edges of the X-ray and light fields are misaligned by 1% of the distance between the X-ray source and the Bucky. An edge falling on the second spot, ±2 cm, indicates an error of 2% at 100 cm. The maximum allowed misalignment is 1% of the source to image distance.

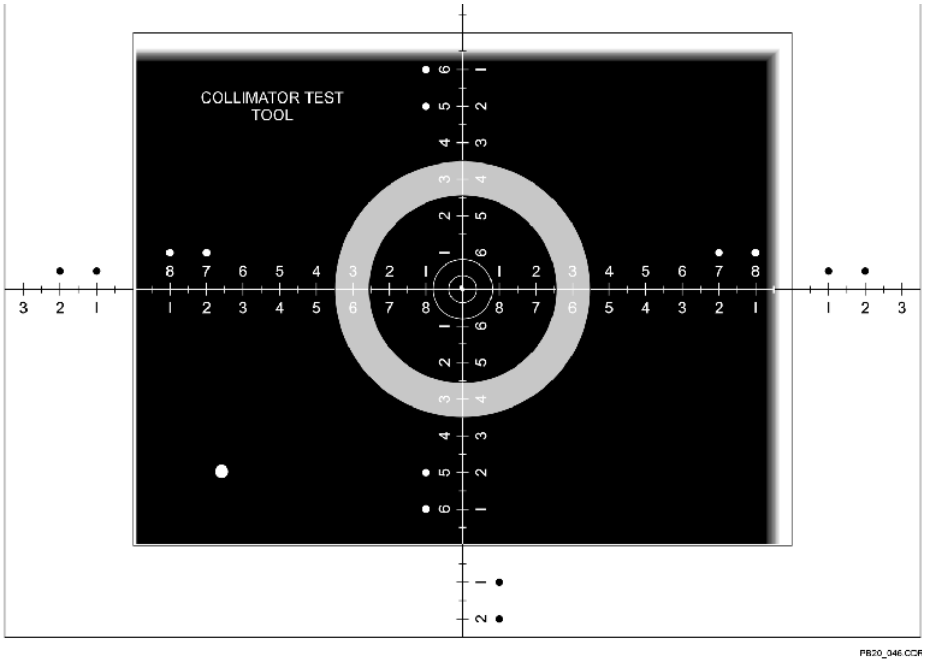


Figure 4-6. Example of Alignment at 1%

Step	Action
6	***If the light field is aligned,*** repeat the entire test for other commonly used distances. For suggested exposures and allowable errors at different distances, refer to Table 4-2. ***If the light field is not aligned,*** go to step 7.

WARNING

Alignment at one distance does not guarantee alignment at all other distances.

Table 4-2. X-ray to Light Field Alignment Tolerance

Distance Between Source and Light Field (Bucky)	Exposure Factors	Maximum Misalignment Allowed by BRH (2%)	VA 1%
40 in. (100 cm)	60 kVp 7 mAs	0.8 in. 2 cm	0.4 in. 1 cm
44 in. (112 cm)	60 kVp 7 mAs	0.9 in. 2.2 cm	0.44 in. 1.1 cm
56 in. (142 cm)	60 kVp 10 mAs	1.12 in. 2.8 cm	0.56 in. 1.4 cm
72 in. (180 cm)	60 kVp 30 mAs	1.44 in. 3.6 cm	0.72 in. 1.8 cm

Step	Action
7	The misalignment verified in step 5 could be caused by one of the following possibilities: • The light field is not centered in transversal direction. Refer to the Collimator service manual that came with the system for the adjustments. • The light field is not centered in longitudinal direction. Refer to the Collimator service manual that came with the system for the adjustments. • The light field is too small or too large. Refer to the OTC service manual that came with the system for the Collimator differential vertical SID adjustments. ***Note:*** *When the X-ray and light field are aligned, repeat the test per step 6.*

Aligning the Collimator Crosshair to the X-ray Field

With the central beam aligned and the light field calibrated with the X-ray field, the Collimator crosshairs can be accurately set to show the central beam. Refer to the Collimator service manual that came with the system for crosshair adjustments.

Verify at minimum and maximum VSID.

Aligning the HSID Central Beam and X-ray Field Center to DirectRay Detector Center

To align the HSID central beam:

Step	Action
1	Position the X-ray tube and Bucky to the maximum HISD (A2, B2, or C2).
2	Align the light field to the test tool.
3	Verify the bead overlap in DRIVEL.
4	If necessary, adjust/compromise positions: A: Transverse and vertical B: Longitudinal and vertical C: Telescope rotation and vertical (transverse only if absolutely necessary)
5	Verify the bead overlap at HSID Min (A1, B1, or C1) and Max.
6	If necessary, adjust A/B/C: Transverse and telescope, vertical and tube angle (last).
7	Set detents and reverify VSID Min and Max.

Checking the Size of the X-ray Field to Collimator Indicated Size Full Field

To check the size of the X-ray field to Collimator indicated size full field:

Step	Action
1	Set the Collimator indicated size to 43 x 35 cm at 100 cm SID using the Auto function.
2	Turn the Collimator to a 45° angle to the DirectRay Detector. ***Note:*** *This is done so that you will be able to see a field size greater than the DirectRay Detector size.*
3	Take an exposure at 70 kVp and 8 mAs.
4	Accept the image.
5	View the image in DRIVEL.
6	Using the measure function, measure the size of the X-ray field. ***Note:*** *The measurement should be set to 1% greater than indicated ±0.5%. This accuracy is to ensure full coverage of the DirectRay Detector.*
7	If this measurement is not correct, refer to the OTC or Collimator service manuals that came with the system for the adjustments.

Checking the Size of the X-ray Field to Collimator Indicated Size

To check the size of the X-ray field to Collimator indicated size:

Step	Action
1	Set the Collimator blades to 18 x 14 indicated on the Collimator at 100 cm. ***Note:*** *No 45° angle is necessary for this procedure.*
2	Make an exposure at 70 kVp and 8 mAs.
3	Accept the image.
4	View the image in DRIVEL.
5	Using the measure function, measure the size of the X-ray field. ***Note:*** *The measurement should be set to ±2% of SID.*
6	If this measurement is not correct, refer to the OTC or Collimator service manuals that came with the system for the adjustments.

Checking the Size of the X-ray Field to Collimator Indicated Size Full Field at 180 cm

To check the size of the X-ray field to Collimator indicated size at 180 cm:

Step	Action
1	Set the Collimator indicated size to 43 x 35 cm at 180 cm SID using the Auto function on the Collimator face.
2	Turn the Collimator to a 45° angle to the DirectRay Detector. ***Note:*** *This is done so that you will be able to see a field size greater than the DirectRay Detector size.*
3	Take an exposure at 70 kVp and 8 mAs.
4	Accept the image.
5	View the image in DRIVEL.
6	Using the measure function, measure the size of the X-ray field. ***Note:*** *The measurement should be set to 1% greater than indicated ±0.5%. This accuracy is to ensure full coverage of the DirectRay Detector.*
7	If this measurement is not correct, refer to the OTC or Collimator service manuals that came with the system for the adjustments.

Checking the Size of the X-ray Field to Collimator Indicated Size at 180 cm

To check the size of the X-ray field to Collimator indicated size at 180 cm:

Step	Action
1	Set the Collimator blades to 18 x 14 indicated on the Collimator at 180 cm. ***Note:*** *No 45° angle is necessary for this procedure.*
2	Make an exposure at 70 kVp and 8 mAs.
3	Accept the image.
4	View the image in DRIVEL.
5	Using the measure function, measure the size of the X-ray field. ***Note:*** *The measurement should be set to ±2% of SID.*
6	If this measurement is not correct, refer to the OTC or Collimator service manuals that came with the system for the adjustments.

Testing Calibration

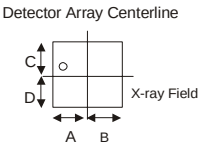
To test calibration, use the following form:

Testing Calibration

LONG error = (A-B)/2

LAT error = (C-D)/2

Ctr/Ctr error = $\sqrt{[\text{LAT error}]^2 + [\text{LONG error}]^2}$



Indicated size:	25 mm Longitudinal x 20 mm Lateral
Light field size:	_____ cm LONG x _____ cm LAT
X-ray field size:	_____ cm LONG x _____ cm LAT
Light to X-ray center/center error:	_____ mm
Crosshair to X-ray center/center error:	_____ cm
Detector Array to X-ray center/center error:	_____ cm
Crosshair to Detector Array center/center error:	_____ cm

(requirement: error < 2% SID)
(VA requirement: error < 1% SID)

Pass: _____

EPEX Testing Calibration.cdr

Calibrating the DirectRay Detector

The DirectRay Detector should be calibrated weekly at the routine chest orientation of 72 in. HSID. In addition, if the daily flat field exposure procedure produces image tones that are not uniform or are otherwise unsatisfactory, the DirectRay Detector should be calibrated.

To calibrate the DirectRay Detector:

Step	Action
1	Ensure that the DirectRay Detector has been powered on for at least one hour so that it has reached thermal equilibrium.
2	Ensure everyone is out of the X-ray room.
3	In the DirectRay Console application's main window, close any open studies and ensure that no patient is selected.
4	From the **Admin** menu, choose **Calibrate**. The Calibration Test panel displays. This panel includes instructions for how to set the technique settings and take exposures for the calibration. ***Note:*** *Refer to the DirectRay Operator Console Service Manual for specific images of the Calibration Test panel and other screens.*

Step	Action
5	Change the technique settings, as defined in your Calibration Test panel.
6	Remove the grid.
7	Take an exposure. The progress of the calibration displays in the calibration panel. ***If the calibration is successful,*** a **1** displays in the calibration panel. ***If the calibration is not successful,*** adjust the technique settings and take another exposure.
8	Click the **Accumulate Calibration** button.
9	Repeat steps 7 and 8 until you have accumulated four calibrations.
10	When you are finished the calibration sequence, click the **End Calibration** button.

If you want to discard the accumulated calibrations and start over, click on the **Restart Calibration Sequence** button.

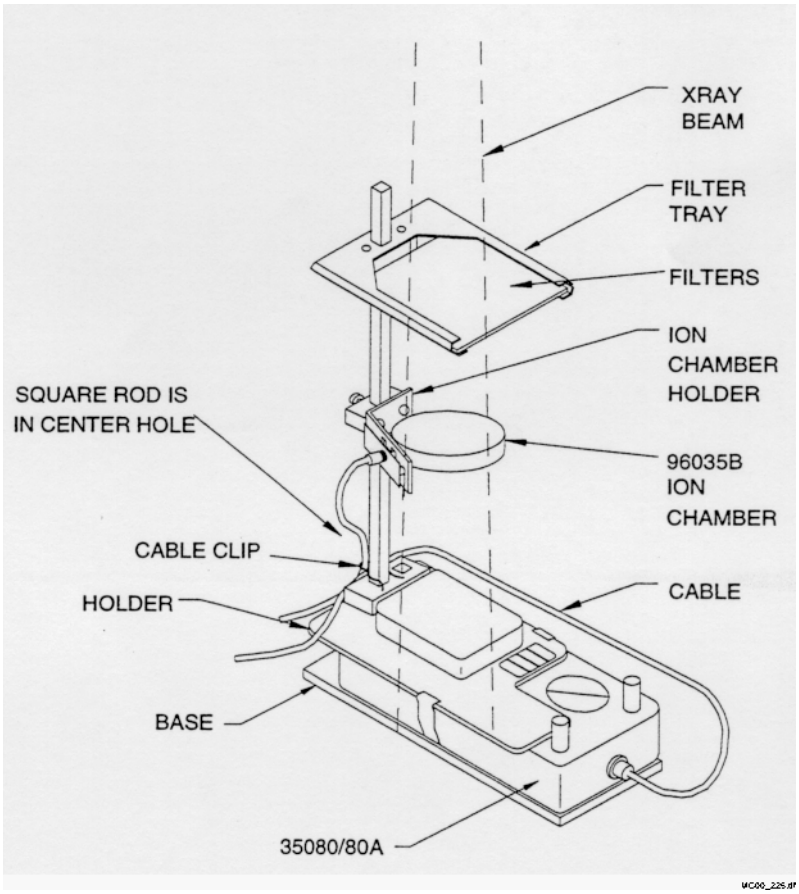
Connecting Test Equipment

Connecting the kV Meter

Figure 4-7 illustrates the over-table HVL setup only for the Keithley Model 10100A Triad Field Service kit. Refer to the over-table HVL setup in the kV meter's operator manual for detailed instructions.

For any other kV meter manufacturers, refer to their operator manual for instructions.

Figure 4-7.
kV Meter Connection



To connect the kV meter:

Step	Action
1	Place the kVp divider and stand on the Bucky.
2	Install the filter pack in the kVp divider.
3	Install the ion chamber in ion chamber holder.
4	Connect the cable to the ion chamber and the kVp divider.
5	Connect the other end of the cable to the dose meter.
6	Connect the dose meter to the laptop.
7	Take the measurements.
8	To uninstall, reverse steps 1 to 6.

Connecting the mAs Meter

To connect the mAs meter:

Step	Action
1	Turn the Generator power off.
2	Remove the mA test jack jumper that is located on the top of the high voltage tank.
3	Connect the mA meter to the mA test jacks.
4	Refer to the mA meter’s operator manual for measurement setup.
5	Turn on the Generator power
6	Make exposures.
7	Measure the mA.
8	Turn the Generator power off.
9	Disconnect the mA meter.
10	Replace the mA text jack jumper.

Adjusting Automatic Exposure Control (AEC)

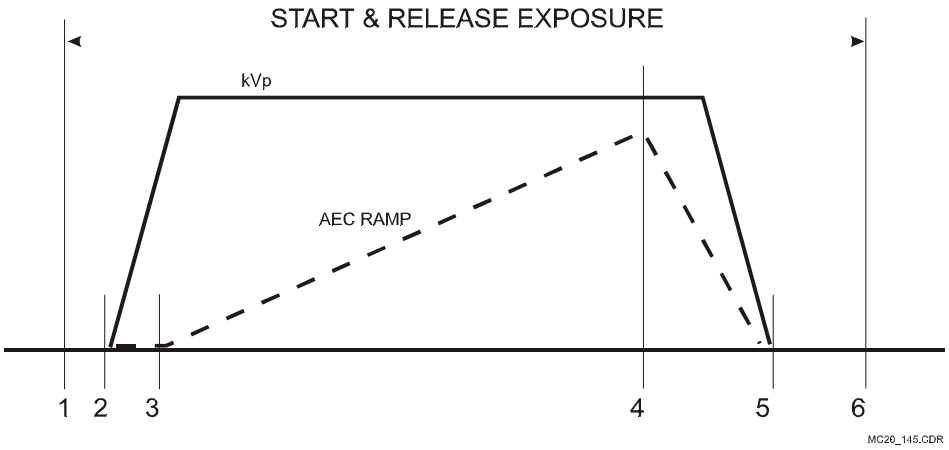
Introduction

This topic covers interfacing and calibration of the AEC.

AEC Limitations: Minimum Response Time

The X-ray Generator (including the AEC pickup chamber) has a minimum response time from the start of the exposure command until there is a kV value sufficient to start producing X-rays. There is a further delay before the start of current flows from the AEC device. Likewise, there is a minimum response time from when the AEC stop command is issued until the kV has actually decreased to the point that X-rays are no longer produced. The following illustration depicts this graphically.

Figure 4-8. Relative Timing of AEC Ramp vs. Exposure Command and kVp



- 1 to 2 is the time from the exposure start command to kVp start. Time = 1 to 3 ms.
- 2 to 3 is the reaction time of the DirectRay Detector to start a current flow. Time = 1 to 3 ms.
- 3 to 4 is the required exposure time.
- 4 is the AEC stop command from the Generator AEC circuits.
- 4 to 5 is the Generator shut down time including cable discharge time and so on. Time = 1.5 to 3.0 ms.
- 1 to 6 is the total time the exposure switch is activated.
- For AEC boards with short AEC time compensation, AEC techniques should have minimum exposure times greater than 5 ms.

AEC Limitations: Maximum Exposure Times

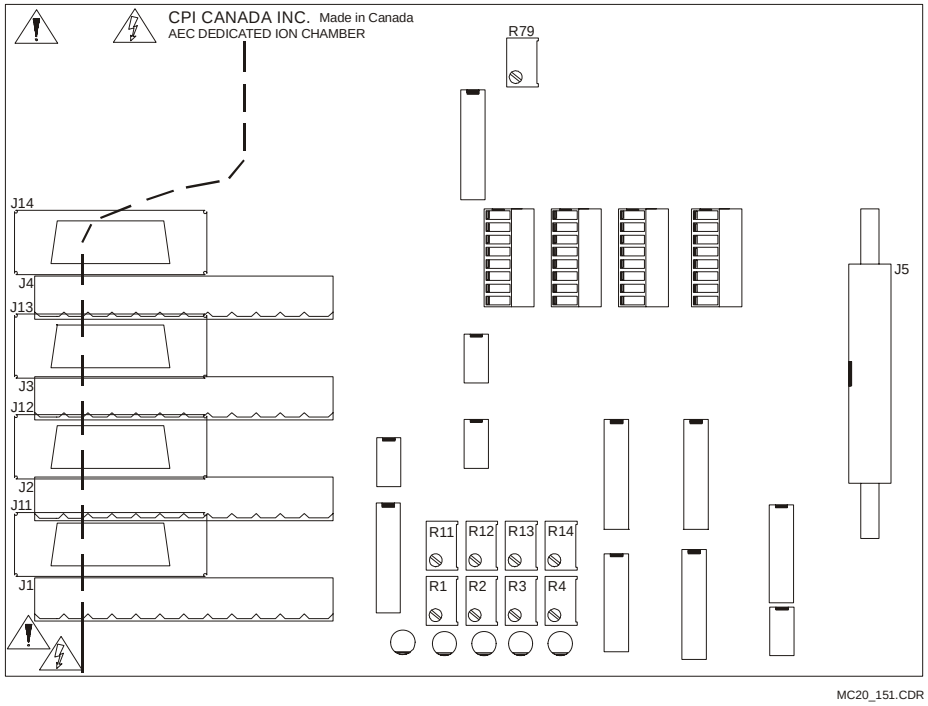
For diagnostic radiography, the FDA limit I ≥ 600 mAs in AEC.

AEC Board

The AEC board shown below is compatible with various makes/models of ion chambers (for example, AID, GE, Vacutec, Philips Amplimat). This AEC board is used as the Generator requires short AEC time compensation.

The EPEX board is fitted with 12 pin in-line connectors (J1 to J4).

Figure 4-9.
Dedicated Ion Chamber AEC Boards



Note: *Do not adjust unless the AEC preamp calibration is out of range.*

AEC board input assignment: Ch 1 = J1/J11.

The R1 potentiometer is used for channel 1 AEC gain adjustment.

The R11 potentiometer is used for channel 1 short AEC exposure time compensation.

R79 adjusts the output of the high voltage bias supply. This is only fitted on versions of this board intended for use with ion chambers which require a separate high voltage bias supply. R79 adjusts the value of the +300 and/or the +500 and the +45 Vdc outputs, and should be set as per the ion chamber manufacturer specifications.

Precalibration Notes

This topic contains information that must be understood and confirmed prior to and/or during AEC calibration.

CAUTION

The procedures in these topics require X-ray exposures. Take all safety precautions to protect personnel from X-radiation.

Should an improper technique be selected, or an AEC fault occur causing no AEC feedback signal to the Generator, the exposure will terminate if the ramp voltage fails to reach 4% of the expected ramp voltage when the exposure time reaches 20% of the selected Back Up Time (BUT).

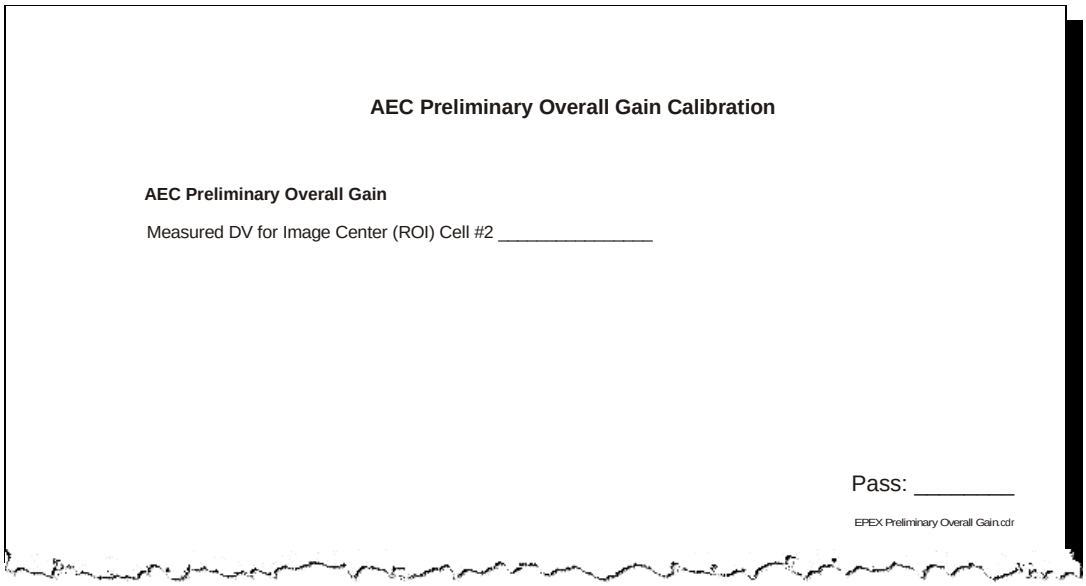
- During calibration, all AEC exposures should be done using mA values that result in exposures in the 50 to 150 ms range **unless stated otherwise**.
- During AEC calibration, always ensure that the central ray is centered relative to the image receptor.
- Ensure that the Collimator is opened sufficiently to cover **all** fields on the AEC pickup device.
- Ensure that the absorber is positioned to fully cover the X-ray field. The absorber must extend a minimum of 3/8 in. (10 mm) beyond the X-ray field.
- All components/assemblies used during AEC calibration must be those which will be used during procedures, and must be positioned as they will be in actual use of the X-ray room.
- The Generator **must** be calibrated before proceeding.
- During AEC calibration, if the exposure times do not change when the mA is varied, it may be that the input signal level to the AEC board is too high. If this happens, check the ramp voltage at the first gain stage output (the first operational amplifier output) on the AEC board for the specific AEC channel. This voltage must never exceed 10 V. If this voltage **does** exceed 10 V, reduce the input signal level as required.

AEC Preliminary Overall Gain Calibration

Note: *DirectRay Detector calibration must be completed prior to performing this procedure.*

To determine the AEC overall gain:

Step	Action
1	From the Generator Toolbox, acquire and accept an image using the technique below: 65 kVp 25 mA 250 ms backup time AEC cell #2 Film screen 2 Grid Speed 2 72 in. HSID Collimator in auto mode No object in the beam, full field size Grid in
2	Use DRIVEL to acquire a DV (Mean) for image center as the ROI.
3	Adjust the master gain pot on the pre-amp and repeat step until DV (Mean) is between 1850 to 1900.
4	Verify AEC Cell terminates prior to backup time.
5	Ensure that the DV (Mean) for image center cell #2 is between 1850 and 1900.
6	Enter the measured DV (Mean) for the image center in the AEC Preliminary Overall Gain Calibration form. Refer to the sample form below.



AEC Preliminary Overall Gain Calibration

AEC Preliminary Overall Gain

Measured DV for Image Center (ROI) Cell #2 _____

Pass: _____

EPEX Preliminary Overall Gain.cdr

AEC kVp Compensation for Film Screen 2

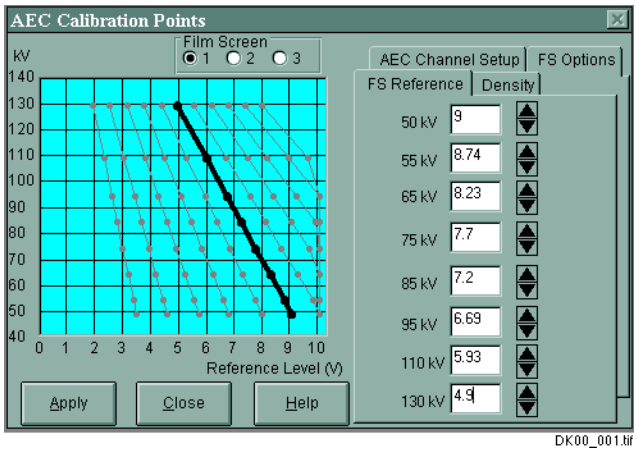
To determine the AEC kVp compensation for Film Screen 2:

Step	Action
1	Connect the Service Laptop to the Generator.
2	From the **GenWare Utility AEC Calibration Points** menu screen, choose **Film screen 2**.
3	Adjust the reference volts as shown in the form below.
4	Acquire exposures using the following techniques: 50 mA 250 ms backup time AEC cell #2 Film screen 2 Grid Speed 2 40 in. HSID or VSID Collimator in auto mode, 25 x 25 cm field size Grid in.
5	Use DRIVEL to acquire a DV (Mean) for image center as the ROI.
6	Ensure all DV (Mean) measured is within 200 of each other and respective to 65 kVp data point in the table.
7	Record the AEC mS, DV (Mean), and the DV (Mean) delta in the AEC kVp Compensation for Film Screen 2 form found in Appendix C. A sample is shown following this procedure.
8	Repeat steps 3 to 7 for each kVp listed on the form.
9	This is an iterative process to adjust the kVp to the reference level to bring the multiple high(s) and low(s) DV (Mean) closer to the DV (Mean) data point at 65 kVp. Do not re-adjust the 65 kVp reference volts. The final exposure should have a Delta $\leq$ 200 to the acquired DV (Mean) at 65 kVp.
10	Repeat this procedure as an iteration. Record only the adjusted reference and the resulting AEC ms, DV (Mean), DV (Mean) delta in the AEC kVp Compensation for Film Screen 2 iteration forms in Appendix C. A sample is shown following this procedure. ***Note:*** *Write N/A or – for the non adjusted data.*

Step	Action
11	After the reference values have been determined for Film Screen 2, change the reference values in Film Screen 1 and 3 to match the reference values in Film Screen 2.
12	Ensure that Film Screen 1, 2, and 3 reference values match. ***Note:*** *The following screen is an example of the values in Film Screen 1. The values in the Film Screen 2 and Film Screen 3 should match the values in Film Screen 1.*

Note: *The numbers in this screen are being shown as an example only. They are not to be used as input values.*

Film Screen 1:



AEC kVp Compensation for Film Screen 2

kVp	50	55	65	75	85	95	110	120	Delta
Phantom Thickness	1.5 in.	1.5 in.	3 in.	3 in.	4.5 in.	4.5 in.	6 in.	6 in.	N/A
AEC ms									N/A
DV (Mean)									
Reference	6.15	5.78	5.15	4.60	4.10	3.75	2.82	2.18	N/A

(requirement: Delta ≤ 200 to the acquired DV (Mean) at 65 kVp.)

Pass: _____

EPEX Omniflex kVp Compensation for Film 2.cdr

2nd Iteration
AEC kVp Compensation for Film Screen 2

kVp	50	55	65	75	85	95	110	120	Delta
Phantom Thickness	1.5 in.	1.5 in.	3 in.	3 in.	4.5 in.	4.5 in.	6 in.	6 in.	N/A
AEC ms									N/A
DV (Mean)									
Reference			5.15						N/A

(requirement: Delta ≤ 200 to the acquired DV (Mean) at 65 kVp.)

Pass: _____

EPEX Omniflex kVp Compensation for Film 2A.cdr

Adjusting the Final Ion Chamber Preamplifier Gain

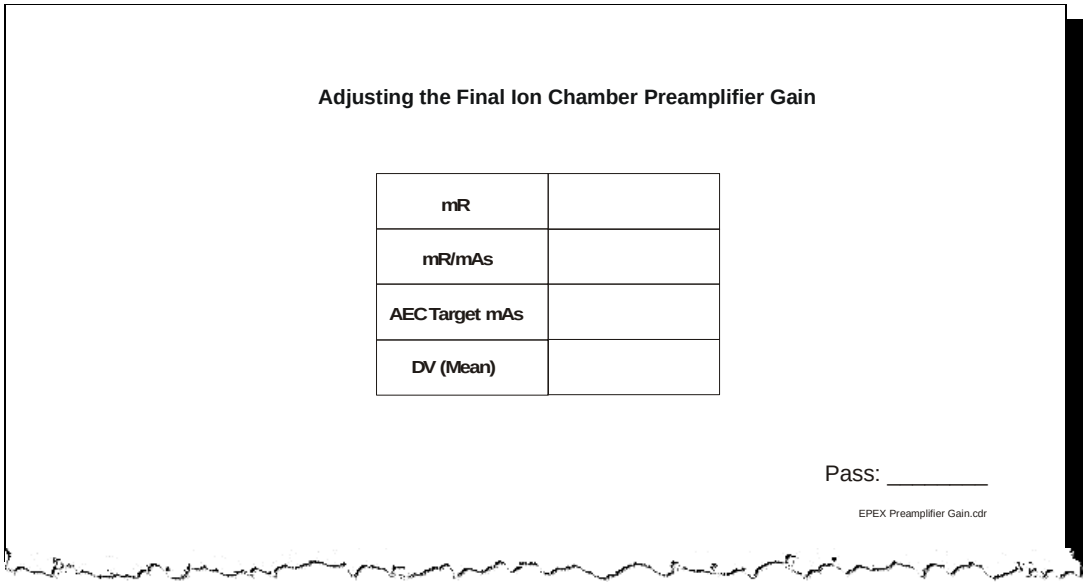
To adjust the Ion Chamber Preamp gain (R26 on the Ion Chamber Preamplifier Board):

CAUTION

The X-ray tube housing temperature may become excessive when taking numerous exposures or when the tube rotor runs for an extended period of time. Prevent damage to the X-ray tube by allowing the X-ray tube assembly time to cool during testing.

Step	Action
1	Position the mR probe centered 61 in. from the focal spot. Collimate to 8 x 8 in. at the probe.
2	Measure the mR at 110 kVp, 100 mA, 100 ms, 10 mAs, and non-AEC.
3	Record the mR in the Adjusting the Final Ion Chamber Preamplifier Gain form in Appendix C. A sample of the form is shown following this procedure.
4	Determine whether the X-ray source assembly mR/mAs equals mR/10. ***Note:*** *Expected value 4.5 ±0.5 mR/mAs.*
5	Record the mR/mAs in the Adjusting the Final Ion Chamber Preamplifier Gain form in Appendix C. A sample of the form is shown following this procedure.
6	Calculate 11÷ (mR/mAs) as the target AEC mAs for 56 in. SID. ***Note:*** *Expected value 2.5 ±0.3 mAs.*
7	Remove the mR probe.
8	Mount 21 mm A1 filtration to the Collimator.
9	Use the following settings: 56-in. SID Grid in, for mid-range focus grid 10 x 10 in. field size Portrait mode
10	Set only the center AEC cell on.

Step	Action
11	Use the following settings: 110 kVp 50 mA 100 ms back up time
12	Acquire exposures and adjust the AEC preamplifier gain to the target calculated mAs ±0.1 mAs.
13	Record the actual mAs for the AEC in the Adjusting the Final Ion Chamber Preamplifier Gain form in Appendix C. A sample of the form is shown following this procedure.
14	For reference, record the DV (Mean) in the digital image center 1 x 1 in. the Adjusting the Final Ion Chamber Preamplifier Gain form in Appendix C. A sample of the form is shown following this procedure.



Adjusting the Final Ion Chamber Preamplifier Gain

mR	
mR/mAs	
AEC Target mAs	
DV (Mean)	

Pass: _____

EPEX Preamplifier Gain.cdr

Ion Chamber Detector Balance–PreAmp

Whenever the AEC has been replaced, the following procedure must be followed.

It is also possible that you may need to make adjustments after performing service, particularly after replacing components or subassemblies.

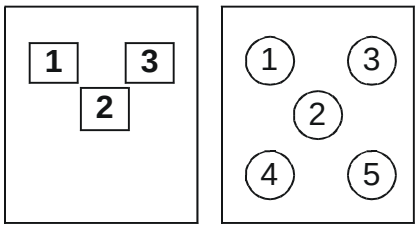
CAUTION

Avoid damage to the X-ray tube by carefully monitoring the tube housing temperature during testing.

To perform an AEC ion chamber adjustment:

Step	Action
1	Remove the Grid.
2	Set to Portrait mode and the SID to 72 in.
3	Open the Collimator to 14 x 17 in.
4	Ensure that there is nothing in the path of the X-ray beam.
5	Use the following settings: 60 kV 25 mA 200 ms backup
6	Ensure that cell #2 (the center cell) is on. For the numbering and layout of the cells, refer to Figure 4-10 on page 4-52.
7	Acquire an exposure.
8	Record the milliseconds in the Verifying Ion Chamber Preamplifier Balance form in Appendix C. A sample of the form is shown following this procedure.
9	Select only cell #1 (the left cell).
10	Acquire an exposure.
11	Record the milliseconds in the Verifying Ion Chamber Preamplifier Balance form in Appendix C. A sample of the form is shown following this procedure.
12	Adjust cell #1’s balance so that it equals cell #2’s ms ±5%.
13	Select only cell #3 (the right cell).
14	Acquire an exposure.

Step	Action
15	Record the milliseconds in the Verifying Ion Chamber Preamplifier Balance form in Appendix C. A sample of the form is shown following this procedure.
16	Adjust cell #3's balance so that it equals cell #2's ms ±5%.
	If there are 5 ion chambers:
17	Set the Bucky to Landscape orientation.
18	Select only cell #5 (the right cell; refer to Figure 4-10).
19	Acquire an exposure.
20	Record the milliseconds in the Verifying Ion Chamber Preamplifier Balance form in Appendix C. A sample of the form is shown following this procedure.
21	Adjust cell #5's balance so that it equals cell #2's ms ±5%.
22	Set the Bucky to Portrait orientation and set the Inverted image setting.
23	Select only cell #4 (the left cell; refer to Figure 4-10).
24	Acquire an exposure.
25	Record the milliseconds in the Verifying Ion Chamber Preamplifier Balance form in Appendix C. A sample of the form is shown following this procedure.
26	Adjust the #4 balance so that it equals cell #2's ms ±5%.



DK20_061.cdr

Figure 4-10.
Adjusting Ion Chambers

Verifying Ion Chamber Preamplifier Balance

Setup:

Grid Speed	medium
kVp	60
mA	25
Phantom	0 in.
Field Size	auto

Balance Data:

	Portrait			Landscape	Portrait/Inverted
AEC Detector(s)	**#1**	**#2**	**#3**	**#5**	**#4**
Detector Selected	**#Lt.**	**#Ctr**	**#Rt.**	**#Rt.**	**#Rt.**
Exposure ms					

Pass: _____

EPEX Ion Chamber Balance.cdr

Chapter 5
Preventive Maintenance

Service procedures must be performed by trained personnel only. This chapter contains system preventive maintenance schedules and checklists

Serviceability and Repairability

All provided products and associated components are designed for replacement or service in a hospital environment. Repair of the DirectRay Detector, the DirectRay Controller, and the DirectRay Console is to be done only by Del authorized representatives.

Contents

Subject	Page
In-Service Observation	5-2
Preventive Maintenance Schedules and Checklists	5-2
System Preventive Maintenance	5-6

In-Service Observation

Observe the operation of the locking mechanisms as the Tower and Bucky are prepared for use. If the mechanism fails to lock or release, the unit should immediately be removed from service and the failure repaired.

Observe the operation of the DirectRay Detector rotation mechanism each time orientation is changed. Irregular movements or other malfunctions should be repaired immediately.

Observe the movement of the Radiographic Table as it is positioned for use. Irregular movements or other malfunctions should be repaired immediately.

The Overhead Tube Crane (OTC), Radiographic Table, and all accessories should be inspected for worn, loose, bent, or broken parts.

Preventive Maintenance Schedules and Checklists

The Semi-Annual and Annual preventive maintenance checklist forms are shown on the following pages. You should perform the tasks listed on the forms, given the preventive maintenance schedule(s) currently required for the site. Reproducible copies of these forms are provided in Appendix C.

Semi–Annual Preventive Maintenance

Semi-Annual Preventive Maintenance Checklist

Inspection Date:_____ Site:_____

System:

Inspection	Comments
❑ Clean and re-grease all HV connections using vapor proof compound.	
❑ Clean the main cabinet as needed. Refer to the Generator service manual.	
❑ Perform the X-ray tube auto calibration routine. Refer to Chapter 4.	
❑ Verify the calibration of the Generator. Refer to manufacturer's documentation.	
❑ Perform any additional tests required by laws governing this installation.	
❑ Perform a flat field exposure to check image quality.	
❑ Check cables; inspect for cable sheath wear, pinching, or excessive bending.	
❑ Perform mA Calibration.	
❑ Perform DirectRay Controller Calibration.	
❑ Preview image(s).	
❑ Confirm modem is operational.	
❑ Check software/firmware revision levels for equipment. Compare with records (refer to Appendix C); update listing, if required.	
❑ Check logfiles for any unusual error messages.	

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EPEX Omniflex Semi-Annual1.cdr

Semi-Annual Preventive Maintenance Checklist

System (cont.):

Inspection	Comments
❑ Check for dust in DirectRay Console.	
❑ Check DirectRay Console fan.	
❑ Check all connections and make sure they are secure.	
❑ Check the UPS.	

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Annual Preventive Maintenance

Annual Preventive Maintenance Checklist

System:

Inspection	Comments
❑ Open the Generator cabinet and examine the unit for any visible damage: missing or loose ground connections, oil leaks, damaged cables, and so on.	
❑ Ensure that there are no obstructions blocking any of the ventilation holes or louvers on the Generator cabinet.	
❑ Inspect ground, handswitch, operator contols, control cables, and strain reliefs for wear and pinching.	
❑ Check U-arm cable drape; inspect for cable sheath wear, pinching, or excessive bending.	
❑ Check sheathing on cables that exit the U-arm and enter the ceiling for pinching, cuts, fraying, or excessive bending.	
❑ Check tightness of all electrical cable connections.	
❑ Check for proper operation of cooling fans; check that blades are clean.	
❑ Check markings on controls and positioner for legibility.	

EPEX Omniflex System Annual.cdr

System Preventive Maintenance

For preventive maintenance for the Collimator, refer to the manufacturer’s service manual.

For preventive maintenance for the X-ray tube, refer to the manufacturer’s service manual.

For preventive maintenance for the Overhead Tube Crane, refer to the manufacturer’s service manual.

For preventive maintenance for the Generator, refer to the manufacturer’s service manual.

For preventive maintenance for the Radiographic Table, refer to the *EPEX Radiographic Table Service Manual*.

For preventive maintenance for the DirectRay Console, refer to the *DirectRay Console Service Manual*.

Chapter 6
Repair and Replacement

This chapter provides information on the location of instructions for the repair and replacement of EPEX/Omniflex IV System components.

For the Generator, refer to the manufacturer's documentation.

For the Overhead Tube Crane, refer to the manufacturer's documentation.

For the X-ray tube, refer to the manufacturer's documentation.

For the Collimator, refer to the manufacturer's documentation.

For the Radiographic Table, refer to the *EPEX Radiographic Service Manual*.

For the Operator Console, refer to the *DirectRay Console Service Manual*.

For software application reinstallion or upgrades, refer to the *DirectRay Console Service Manual*.

Chapter 7
Diagnostics and Troubleshooting

This chapter describes the diagnostic and troubleshooting procedures for the EPEX/Omniflex IV System.

Contents

Subject	Page
Troubleshooting Overview	7-2
Troubleshooting Service Tools	7-3
Accessing Tail Log Files	7-7
Responding to Error Messages	7-10
Troubleshooting System Problems	7-14

Troubleshooting Overview

The System Controller initiates service diagnostics via the SCSI-2 interface. Service diagnostics involves initiating power-on tests and component self-tests. Errors are reported to a log file.

This chapter provides:

- General information on error logs
- Recommendations for responding to error messages
- Troubleshooting guidelines
- Reference information on error codes

Troubleshooting Service Tools

When Service logs in (locally), the DirectRay Console Task Launcher is opened, but no functions are automatically started. There are also additional minimized windows.

Figure 7-1. DirectRay Console Task Launcher

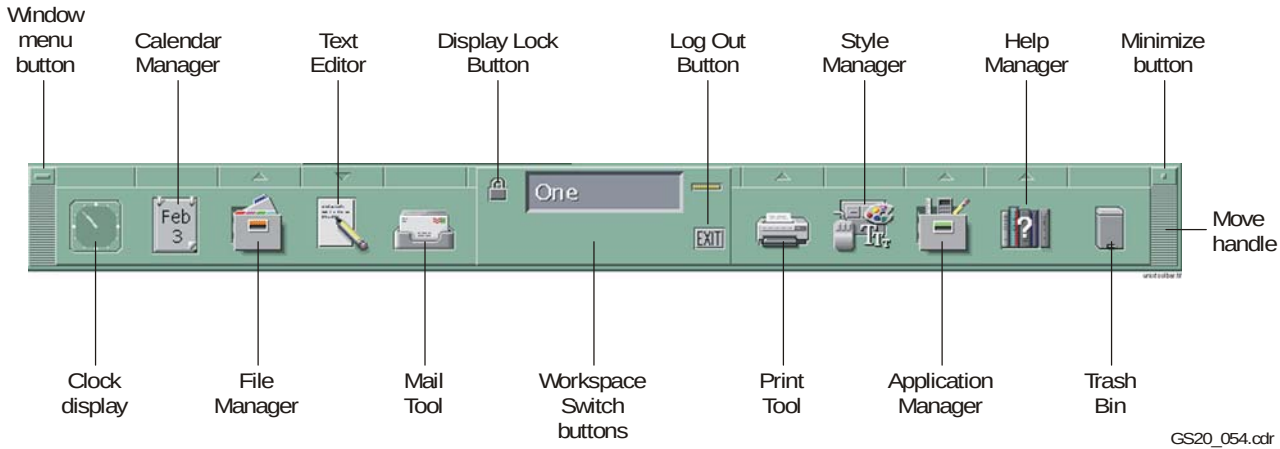
Netscape

The top layer Netscape page is the default screen to service menus and files.

UNIX Toolbar

Clicking on the main menu and moving the window reveals the common desktop environment. A UNIX Toolbar is located at the bottom of the screen.

Figure 7-2. UNIX Toolbar



From the UNIX Toolbar, the terminal popup menu is used to telnet to other network devices or to enter UNIX command lines. Service can telnet to the DirectRay Console to obtain command lines remotely and to upload/ download files to the DirectRay Console using the FTP protocol.

Calculator

A standard scientific calculator is available from the desktop.

SCSI Error Handling

Error handling messages between the DirectRay Controller and the DirectRay Console CPU are categorized into two types, depending on the action required to recover:

- **Warnings**–given when a problem is detectable and recoverable with no loss of system functionality and is not likely to be indicative of a system failure. For example, an attempt to initiate an image capture before all systems are ready produces a warning.
- **Errors**–problems that impact system performance and require operator intervention or notification. An error may or may not be recoverable and may be indicative of a system failure. An unsuccessful recovery can be considered a Fatal error. Another example of an error is loss of communication with the currently selected DirectRay Detector.

Errors and warnings are further categorized into “sticky” and “non-sticky.”

- **Sticky Errors or Warnings**–remain in the system after they have been read by the system controller. The DirectRay Controller subsystem that detected and posted the error or warning may optionally remove the error or warning condition if it has been able to recover from the problem. For example, a sticky error would be the incorrect operation of the high voltage system.
- **Non-Sticky Errors or Warnings**–are removed from the system once they have been read by the system controller. If the condition that caused the initial error or warning persists, the error may be repeatedly re-posted after reading. For example, a non-sticky error or warning will be generated if communication is lost with the attached DirectRay Detector.

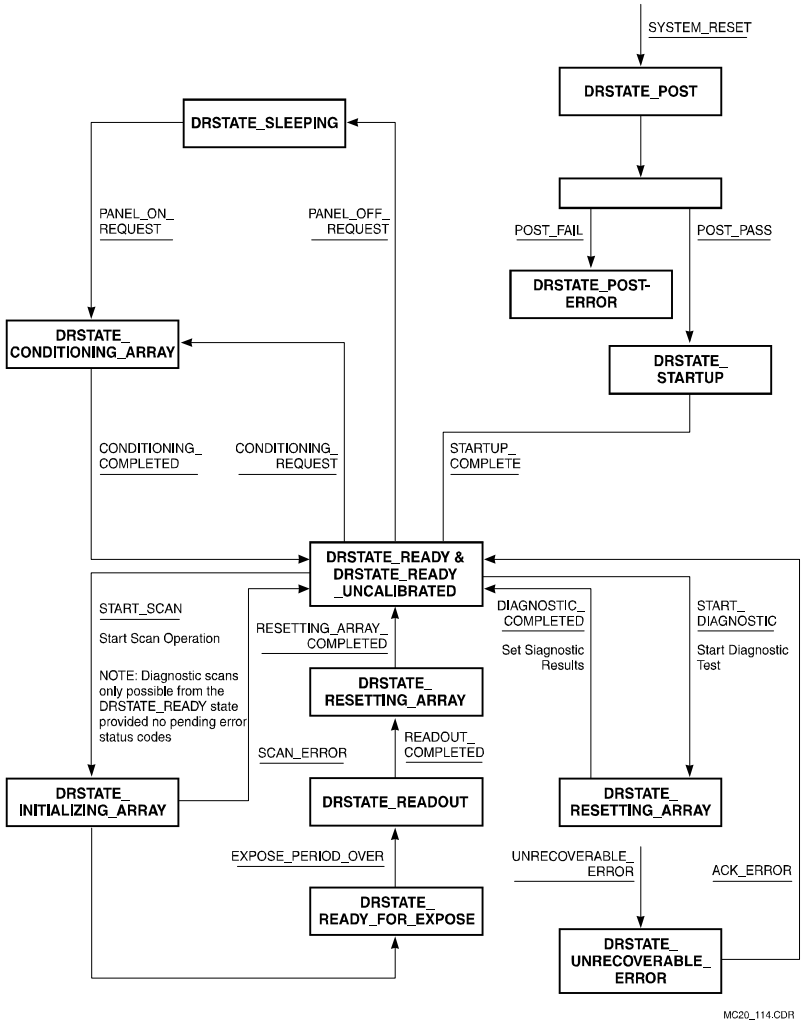
Error and Warning Reporting

Errors in the DirectRay Controller are reported over the SCSI system control interface. Errors reported over the system control interface are classified into two types:

- **Command Errors**–are errors related to commands sent over the system control interface. The system control interface returns explanatory information. The error is reported once, then cleared. Command errors include, but are not limited to:
  - Command field errors
  - Unsupported commands
  - Out of sequence commands
  - Communication protocol errors
- **System Errors**–are due to errors detected in the DirectRay Controller. In this case, the error status is reported through the system control interface. System errors prevent “Normal” type scan commands from being executed. An attempt to send these commands will fail. Commands that are not related to generating images for medical diagnostic purposes will work normally.

The error and warning reporting system is illustrated in the following figure.

Figure 7-3. Error and Warning System



Accessing Tail Log Files

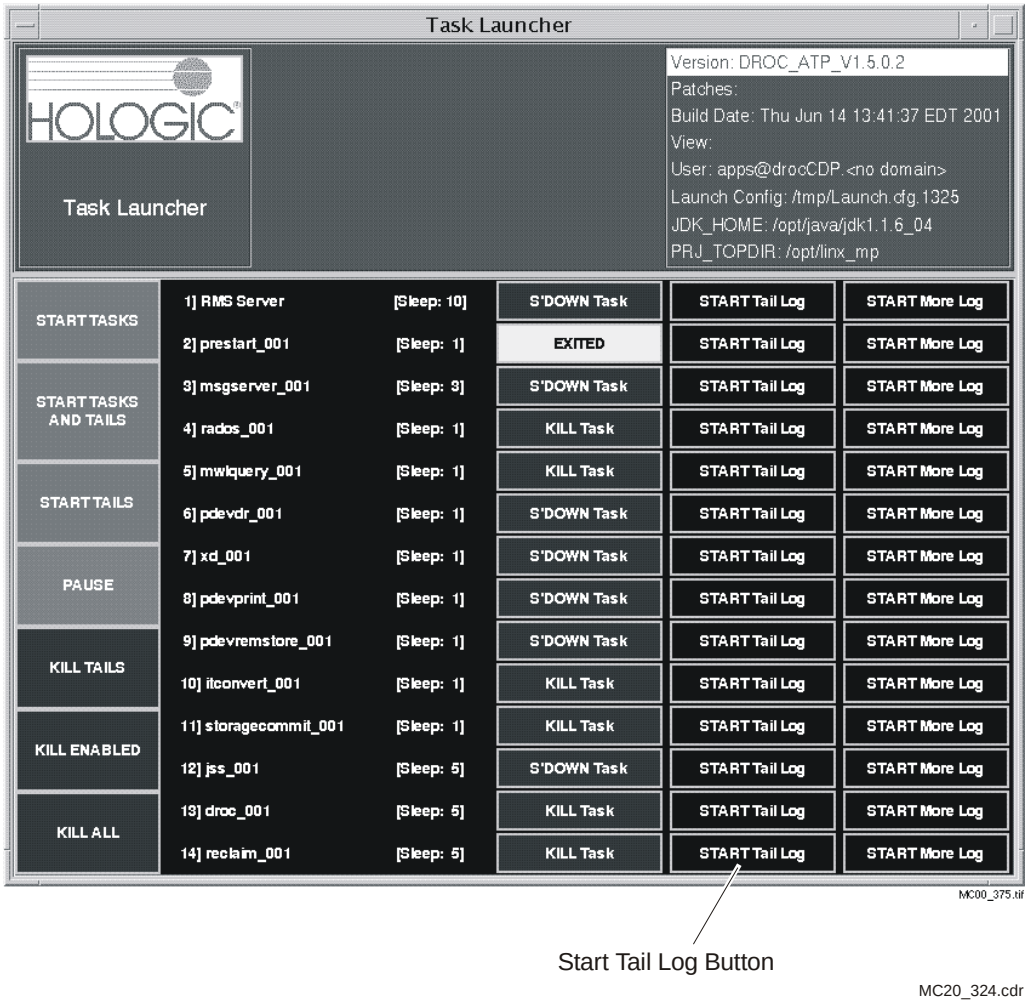
Error log files are accessed using the DROC Task Launcher. Error log files are organized by module.

To access the end of the log, use the **Start Tail Log**.

To access the entire log file, use the **Start More Log**.

For example, the end of the list of errors concerning DICOM printing are accessed through the **Start Tail Log**. Fatal error events are clearly logged as fatal. Any tasks that cannot continue processing as a result of the error are also indicated.

The following screen shows the DROC Task Launcher with **Start Tail Log** indicated.


Task Launcher
HOLOGIC
Task Launcher
Version: DROC_ATP_V1.5.0.2
Patches:
Build Date: Thu Jun 14 13:41:37 EDT 2001
View:
User: apps@drocCDP.<no domain>
Launch Config: /tmp/Launch.cfg.1325
JDK_HOME: /opt/java/jdk1.1.6_04
PRJ_TOPDIR: /opt/linx_mp
START TASKS
START TASKS AND TAILS
START TAILS
PAUSE
KILL TAILS
KILL ENABLED
KILL ALL
1] RMS Server [Sleep: 10] S'DOWN Task START Tail Log START More Log
2] prestart_001 [Sleep: 1] EXITED START Tail Log START More Log
3] msgserver_001 [Sleep: 3] S'DOWN Task START Tail Log START More Log
4] rados_001 [Sleep: 1] KILL Task START Tail Log START More Log
5] mwlquery_001 [Sleep: 1] KILL Task START Tail Log START More Log
6] pdevdr_001 [Sleep: 1] S'DOWN Task START Tail Log START More Log
7] xd_001 [Sleep: 1] S'DOWN Task START Tail Log START More Log
8] pdevprint_001 [Sleep: 1] S'DOWN Task START Tail Log START More Log
9] pdevremstore_001 [Sleep: 1] S'DOWN Task START Tail Log START More Log
10] itconvert_001 [Sleep: 1] KILL Task START Tail Log START More Log
11] storagecommit_001 [Sleep: 1] KILL Task START Tail Log START More Log
12] jss_001 [Sleep: 5] S'DOWN Task START Tail Log START More Log
13] droc_001 [Sleep: 5] KILL Task START Tail Log START More Log
14] reclaim_001 [Sleep: 5] KILL Task START Tail Log START More Log
MC00_375.tif

Start Tail Log Button

MC20_324.cdr

Table 7-1. Error Log Module

Status Bar	Meaning
1. RMS Server	Lists, adds, deletes the resources.
2. prestart_001	Cleanup utility (creates, then completes).
3. msgserver_001	Holds, adds, deletes the alarms.
4. rados_001	The database for patient demographics.
5. mwlquery_001	Service which interfaces between the DirectRay Console and the Modality Worklist provider.
6. pdevdr_001	Service which interfaces between the DirectRay Console and the DirectRay Controller over SCSI.
7. xd_001	Service which shows the interface between the WAMI and the X-ray Generator.
8. pdevprint_001	Service which interfaces the DirectRay Console to the DICOM printers.
9. pdevremstore_001	Service which interfaces the DirectRay Console to the DICOM store devices.
10. itconvert_001	Service which interfaces the DirectRay Console to the Inverse Topography function.
11. storagecommit_001	Service which interfaces between the DirectRay Console and archive devices that support Storage Commit. The Storage Commit function enables the archive device to send a message to the DirectRay Console accepting responsibility for the image. The server sends these messages to the DirectRay Console.
12. jss_001	Service which queues jobs for output devices.
13. droc_001	Main DirectRay Console user interface application software.
14. reclaim_001	Performs reclaim high water mark on the database. How many images to be stored on the hard drive before overwriting files.

Accessing Log Files in a Terminal Session

Typically, you will access log files using the Task Launcher window. However, you may need to view the ASCII logs in a terminal session window. For example, if you have logged in as **apps** and are running or have run Netscape, you will not be able to view the logs using Task Launcher.

The log files are stored in the directory **/linx_mp/logs**.

To view the available log files, enter the following command:

```
ls -l *0.log*
```

Additional Logs Accessible from a Terminal Session

Daily reports are stored in the **/linx_mp/logs/reports** directory. These reports include:

- Number of patients processed
- Number of images accepted and rejected
- Number of system reboots

DirectRay Controller Log Files Stored on the DirectRay Console

Every time the DirectRay Console is rebooted, the DirectRay Controller log files are copied, in Z-compressed format, to the **/linx_mp/logs/draclogs** directory on the DirectRay Console.

You would only need to look at these files if directed to do so by Del Support.

Responding to Error Messages

Error codes at the system level, possible causes, and recommended action to remedy the problem are detailed in Table 7-2.

Table 7-2. System-Level Error Codes

Error	Error Type	Possible Cause	Recommended Action
A0	Undetermined mAs	• Undetermined mAs; the exposure was aborted • Premature release of the X-ray exposure switch will cause a lower mAs exposure • HV Cables • Tube arcing • Rotors not running correctly	1. Connect the mAs Meter. 2. Connect the scope; expose, view kV and mA waveforms.
A1	DirectRay Detector Orientation Fault	• Orientation/sensing signals crossed • Check for SCSI errors	1. Verify Bucky has power. 2. Verify DirectRay Detector limit switches and analog array orientation signal from the Bucky. 3. Verify Generator Panel M1. 4. Verify Generator Panel N1 connector J4 Pin 18 and 19 have signals and J3 has signals. 5. Verify Tube Stand Panel J2 has signals on Pin 5, Pin 1, Pin 9 for long signals; and Pin 10, Pin 2, and Pin 11 carry cross signals. 6. Verify I/O Board TP16 has long signals and TP18 carries cross signals.
A2	Door Interlock Fault	• Safety circuit tripped	Ensure the door Safety Interlock Switch is closed.

Table 7-2. System-Level Error Codes

Error	Error Type	Possible Cause	Recommended Action
A3	Bucky Fault	Drive motor not moving	1. Verify U-arm J1 connector has power. 2. Deselect Bucky and press **RESET** (located in the radiography control group). 3. Check the Bucky Enable and Bucky Return signals. 4. Verify J1-12 and J1-13 close in Bucky. 5. Verify Generator Panel N1 J4-12 and 13 have signals. 6. Verify System Controller Motherboard J20-1 has signal and goes to 8 V gnd. Verify J20-2 and J39-22 have signals. 7. Verify Generator Panel M1 J1-22 has signal. 8. Verify WAMI J1-22 has signal.
A4	(Reserved)		
A5	Communication Fault	• Communication fault between the DirectRay Console and the Generator • Tube arcing • Handswitch prematurely released	1. Released handswitch too early. 2. Check the prep expose_ready signals going to the Generator, and the prep_ready and xray_ready signals from the Generator.
A6	kV Error	• mA problems • Filament temperature too high	1. Suspect miscalibration. 2. Check the kV feedback on the HF Power Board. 3. Scope hV transformer; check waveform. 4. Verify TP2 and TP3 for mA and kV.
A7	Filament Error	• Overcurrent • Tube arcing • Open circuit; no Filament • Cable problem • Cathode fault from IGBT drivers	Review Filament circuit.
A8	mA Overload Error	• Bad plug • mA out of bounds for exposure • Filament circuit fault	1. Verify mA requested is within bounds. 2. Review Filament circuit. 3. Check plugs.

Table 7-2. System-Level Error Codes

Error	Error Type	Possible Cause	Recommended Action
A9	Generator Lost Communication with X–ray Control		1. Verify that the HF Logic Board is properly seated. 2. Verify the baud rate between the HF Logic Board and the CPU Board. 3. Verify RS232 connection.
1A	Generator Not Resetting	• Fuse blown • IGBT Shorted • Bridge Rectifier Blown • Check 500 V Rail	1. Verify X-ray tube is plugged in securely. 2. Verify the countdown sequence from the X-ray Generator. 3. HT cables are properly seated. 4. Check the 500 V Rail. 5. Part out of the HF Power Board.
2A	600 Power Out of Spec	• Blown Bridge Rectifier • Lost one phase of 3-phase power	1. Press **RESET** (located in the radiography control group) and try the exposure again. 2. Check the 3-phase fuses and voltages.
3A	V600 Power Too High		1. Press **RESET** (located in the radiography control group) and try the exposure again. 2. Check the 3-phase fuses and voltages. 3. Check the rectifier output voltages.
4A	Boost Error	• Starter Problem • Check Pin 9 and Pin 12 on Starter Board • Voltages on Com-phase on Com-main • Check windings	1. Press **RESET** (located in the radiography control group) and try the exposure again. 2. Check power input to the starter. 3. Check the Rotor_on and HV_lo signals to the starter.
5A	(Reserved)		
6A	AC 3-Phase Error	Check Detector Board	1. Check the fuses and voltages.
7A	V600 Power Too Low	• Verify DC Rail • IGBT Blown • Check Inverters	1. Check the 3-phase fuses and voltages. 2. Check the rectifier output voltages.
9A	Technique Out of Bounds	Calibration problem	1. Ensure mA and kV requested are reasonable. 2. Suspect miscalibration. 3. Verify mA stations. 4. Verify the Filament reading.

Table 7-2. System-Level Error Codes

Error	Error Type	Possible Cause	Recommended Action
B0	Sync Pulse Error		Press **RESET** (located in the radiography control group) and try the exposure again.
B1	No Digital Input	• Exposure request timed out • Bucky contacts no closing • No exposure taken	1. Exposure never started. 2. Exposure not taken during 8-second time available. 3. Time out flag.
B2	Abort Exposure	No mAs	Handswitch let off too soon.
B3	X-ray Switch Jammed		Check the handswitch or wiring.
B5	mAs Not Reached and Time was Stopped	• Too low mA • Filament out of calibration • Time exceeded 130% of the expected mAs	1. Press **RESET** (located in the radiography control group) and try the exposure again. 2. Suspect miscalibration.
2B	Portrait/Landscape Position Fault		Verify Collimator is On.

Troubleshooting System Problems

Symptoms of system problems, probable causes, and recommended actions are detailed in Table 7-3.

Table 7-3. Troubleshooting System Problems

Symptom	Possible Cause(s)	Recommended Action
X-ray Generator Start Up Failure		• Check DS1 light on Generator Transformer. • Verify 24 VKA Circuit available to DirectRay Console. • Verify relay K1 is available to the LVLE circuit. • Ensure K2 relay on Remote ON/OFF Board energizes. • Verify K5 relay energizes.
X-ray Generator POST Failure		Refer to the X-ray Generator service manual.
DirectRay Console POST Failure	Devices could be hung	• Verify via DirectRay Console Tasklauncher that all device listings are successfully loaded. • Start TailLog on suspected error device.
DirectRay Controller Boot Failure	Devices could be hung	• Enter **Ctrl-D** at service keyboard, enter password to access DirectRay Controller Service menu display with “Sequencer in standby”. • Monitor POST routine and check for errors. • Verify initialization of RAM Test passed. • Verify HV Control Voltage. • Test the Erase Circuit Can be Turned ON/OFF. • Run Initialization Read Out Sequence and check for Gate Failure. • Check if reset Due to Watchdog timeout. • Monitor DirectRay Detector internal Temp not to exceed Maximum Threshold. • Verify integrity of Load Gain Cal. Map. • Ensure not loading Bad Pixel Map. • Ensure initialize DirectRay Controller Panel.
Communication Error		Ensure Generator powered up.
Generator Status Indicator	Error condition such as communication error	Verify Generator Status fields indicate HUOOLUNGS.
Cannot Enter Patient Data		• Verify correct character string entered. • Ensure mandatory field have data.

Table 7-3. Troubleshooting System Problems

Symptom	Possible Cause(s)	Recommended Action
Status Bar Indicates Problem		• Sleep condition, press **B** to wake up the DirectRay Controller. • Error condition is blocked, call Service.
DirectRay Detector Will Not Rotate		• Check into the logic of the Tower.
Bucky Will Not Move Vertically		• Check into the logic of the Tower. • Verify vertical latch handle is working. • Verify power to the Tower. • Verify locks disengaged. • Verify LVLE to vertical latch assembly.
Tube Does Not Position Properly		• Verify tube positioning is not at the limit switches. • Manually move the tube to the to the midposition and rotate the DirectRay Detector for recal.
Exposure Failed	• Bucky not in motion • Communication failure	• Check control circuit. • Check WAMI. • Check System Controller Motherboard. • Check Remote ON/OFF Board. • Check Power Supply Board. • Check Rotor Controller I/O Board. • Check System Controller I/O Board.
DirectRay Controller POST Failure	PAC failed	• Verify HV control. • Reset calibration of HV for zero offset and gain. • Replace DirectRay Controller. • Ensure cables are properly connected. • Review error log file. • Test HV feedback has decayed 20V within 2 seconds. • Test erase lights on DirectRay Controller. • Run initialize readout sequence and check for EG&Gor gate failure. • Check if reset due to watchdog timeout. • Verify internal temperature not exceeded threshold. • “Override power-on test failure.”

Table 7-3. Troubleshooting System Problems

Symptom	Possible Cause(s)	Recommended Action
Filament Failure	Failure to satisfy logic requests.	• Check WAMI connections. • Replace X-ray tube. • Check System Controller Board. • Check Remote ON/OFF Board. • Check Power Supply Board. • Check I/O Board. • Check System Controller Motherboard.
AEC Failure		Timer error.
Rotor Failure		• Ensure proper commands are sent to the Starter by checking Pins on G1TB2: Pin 4 = Rotor ON Interlock Pin 6 = Rotor Break Pin 9 high = Rotor ON Pin 9 and Pin 11 high = High Speed Pin 9 and Pin 11 low = Break Pins 4, 9, 11 zero volts equals Command.
Image Preview Error Condition		• Clean out the old database using command mprun Rdow. Make -dropdb Rados. Process is detailed in the *DirectRay Console Service Manual*.
Collimator Failure		• If Collimator field size does adjust to panel orientation, verify Collimator connections. • Verify panel orientation. • Verify manual collimation at U-arm console. • Verify Collimator light functional. • Rotate the DirectRay Detector for recal.
Unacceptable Preview Image		Verify proper orientation. Refer to Chapter 10 in the *DirectRay Console Service Manual*.
Output Device Error	Previous image printing instead of current image	Ensure setup outputs are properly selected. Details are in Chapter 4 in the *DirectRay Console Service Manual*.
Tower Moving the Wrong Way		• A/D Conversion not correct. • Tower not making adjustment.

Appendix A
EPEX/Omniflex IV Specifications

This appendix details the EPEX/Omniflex IV System specifications.

Contents

Subject	Page
Subsystem Specifications	A-2
Environment	A-12
Installation Requirements	A-12

Subsystem Specifications

This topic contains specifications for the following EPEX/Omniflex IV subsystems:

- DirectRay Image Capture system (DirectRay Detector and DirectRay Controller)
- Overhead Tube Crane
- DirectRay Console
- X-ray Generator
- X-ray Tube
- Radiographic Table

DirectRay Image Capture System

Weight	DirectRay Detector 8.6 kg (19 lb) DirectRay Controller 7.3 kg (16.3 lb)
Dimensions	DirectRay Detector Width: 46.7 cm (18.4 in.) Height: 46.7 cm (18.4 in.) Depth: 4.3 cm (1.7 in.) DirectRay Controller Width: 49.5 cm (19.5 in.) Height: 37.8 cm (14.9 in.) Depth: 9.4 cm (3.7 in.)
Image Area	Full field 35 x 43 cm (14 x 17 in.) active image area
Detector Pixel	139 µm 129 µm x 129 µm active element size 2560 x 3072 detector element matrix 89% geometric fill factor
Presampling MTF	98% at 1.0 cycles/mm 89% at 2.0 cycles/mm 70% at 3.0 cycles/mm
Static Load	18 kg (39 lb) applied to the front surface over a nominal 10 x 10 cm (4 x 4 in.) area

Overhead Tube Crane

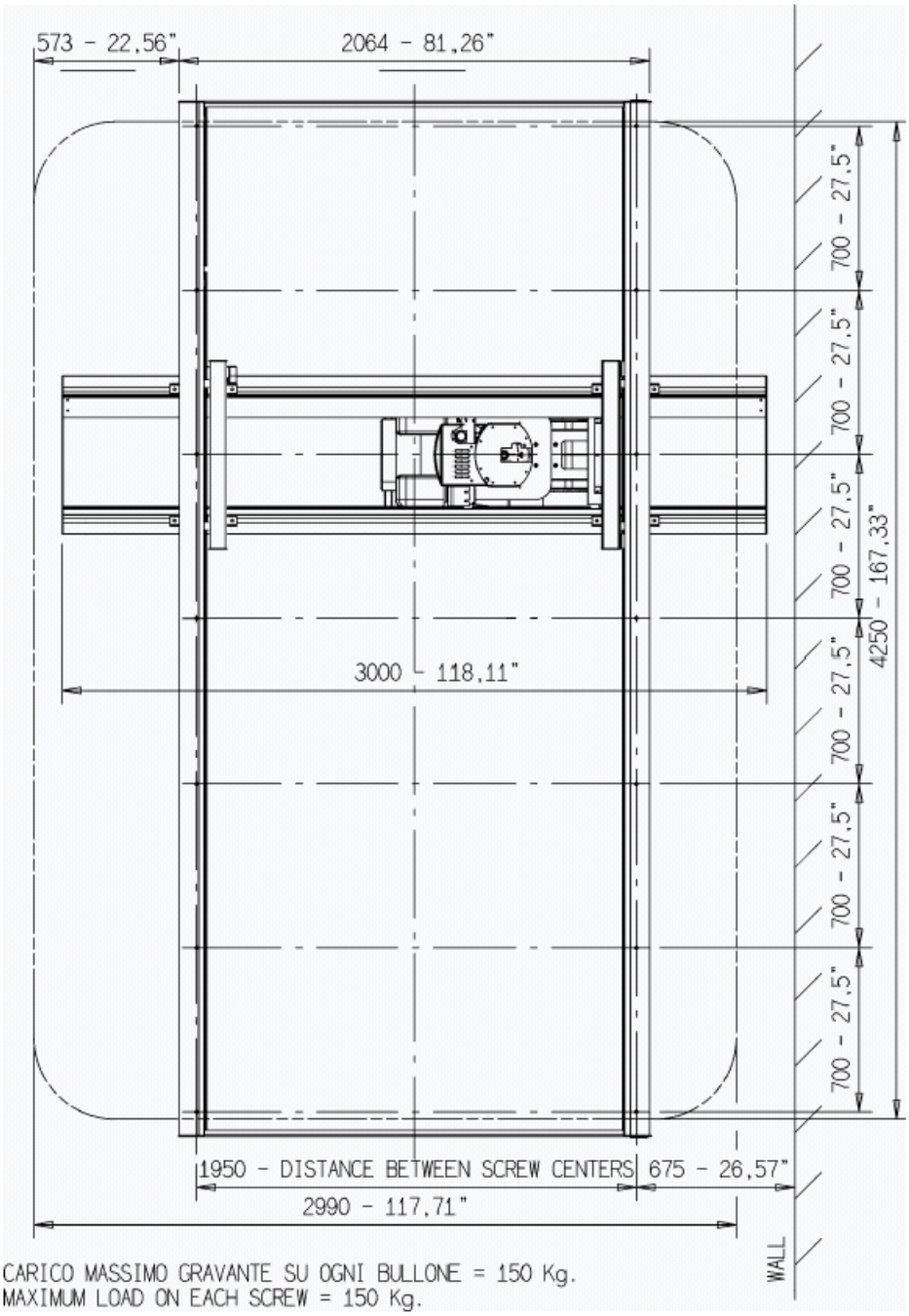
Telescopic Carriage Weight	170 kg (374 lb)
Rails Weight	170 kg (374 lb)
Telescopic Carriage Size	Width: 70 cm (28 in.) Depth: 95 cm (38 in.) Height: 105 cm (42 in.)
Rail Size	Width: 85 cm (34 in.) Depth: 455 cm (182 in.) Height: 50 cm (20 in.)
Electrical	Single phase 115 V to 230 V (±10%), 50/60 Hz, 300 VA
Ceiling Rails Longitudinal Length	4400 mm
Ceiling Rails Lateral Length	3000 mm
Ceiling Rails Longitudinal Travel	3700 mm
Ceiling Rails Lateral Travel	2230 mm
Exploitation Area	4370 x 2950 mm
Tube Vertical Travel	1600 mm
Focal Spot/Telescopic Axis Distance	432 mm
Minimum Focal Spot/Ceiling Distance	730 mm
Typical Room Ceiling Height	2600 mm
Tube Rotation Around Telescope Axis	360° with continuous locking capability and position detent every 90°
Tube Rotation Around Horizontal Axis	±115° with continuous locking capability and position detent every 90°
Counterbalancing System	By means of a spring. Fine adjustment by means of counterweight plates.
Balanced Weight Range	From 37 to 46 kg (81 to 102 lb)
Maximum Effort for Longitudinal Movement	< 5 kg (starting effort)

Maximum Effort for Lateral Movement	< 5 kg (starting effort)
Longitudinal Movement Brake Type	Negative–24 Vdc
Lateral Movement Brake Type	Negative–24 Vdc
Vertical Movement Brake Type	Negative–24 Vdc
Tube Arm Rotation Brake Type	Negative–24 Vdc
Tube Angulation Brake Type	Negative–24 Vdc
FFD Indication Type	By means of a digital display
FFD Indication Accuracy	±1 cm
Tube Rotation Indication Type	By means of a digital display
Tube Rotation Indication Accuracy	±1°

Overhead Tube Crane Physical Specifications

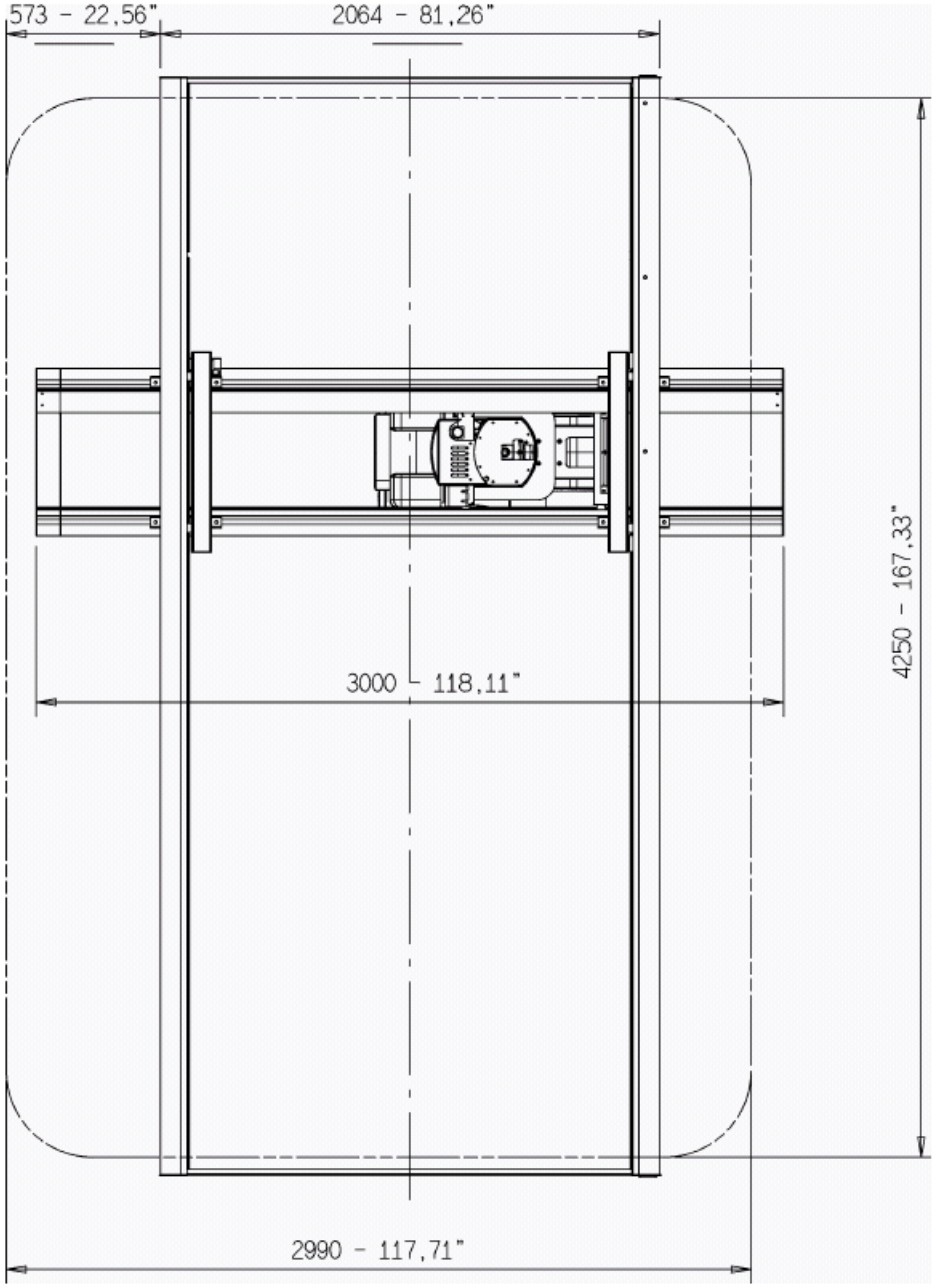
The outline of the Overhead Tube Crane is detailed in the following illustration.

Figure A-1. Overhead Tube Crane Outline



The tube coverage area is illustrated in the following drawing.

Figure A-2. Tube Coverage Area



DirectRay Console

Weight	159 kg (350 lb)
Base	Width: 71 cm (28 in.) Depth: 49 cm (19 in.) Height: 100 cm (39 in.) with monitor 150 cm (59 in.) without monitor
Top Surface	Width: 84 cm (33 in.) Depth: 56 cm (22 in.)
Clearance	30 cm (12 in.) minimum on both sides 75 cm (30 in.) minimum in front
Weight	125 kg (275 lb) without monitor 156 kg (350 lb) with monitor
Electrical	US: 115 Vac, 50/60 Hz, 5 A Europe: 220 Vac, 50/60 Hz, 3 A

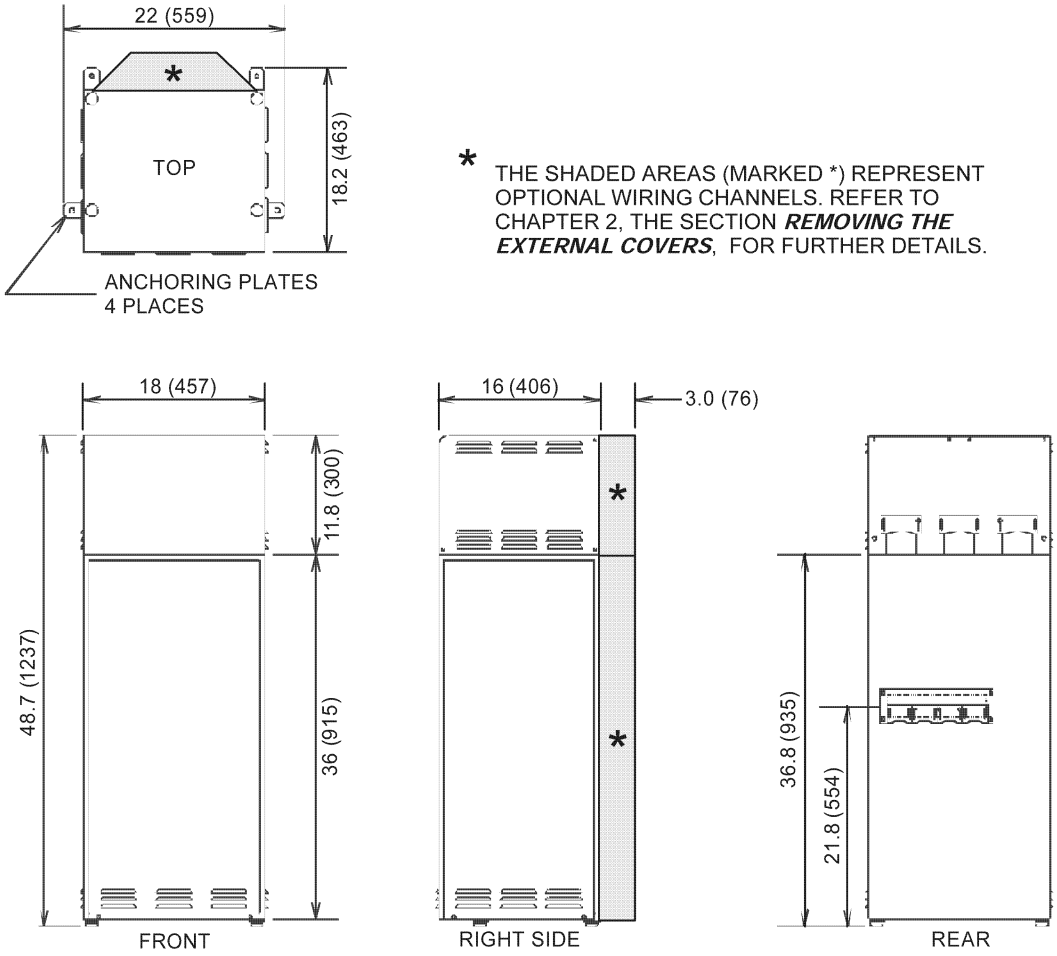
X-ray Generator

Cabinet Weight	159 kg (350 lb)
Cabinet Dimensions	Width: 46 cm (18 in.) Depth: 41 cm (16 in.) Height: 145 cm (57 in.)
Output	80 kV high frequency 100 mA @ 80 kVP 800 mA @ 100 kVP 500 mA @ 150 kVP 40 to 150 kVP 0.5 to 1000 mA
Line Voltage Range	±10%
High Voltage Ripple	4 kVP @ 100 kVP (typical)
Other Features	Dual speed starter APR and AEC programmable by operator Two and three point manual techniques Manual APR/AEC override 380/440/480 Vac, 3 phase

X-ray Generator Physical Specifications

The outline of the X-ray Generator is detailed in the following illustration.

Figure A-3. Generator Outline



X-ray Tube

Nominal Voltage	150 kVp
Anode Speed	3000/9000 rpm
Anode Heat Storage Capacity	400 kHu
Focal Spots	6 and 1/2
Anode Material	RTM
Target Diameter	101.6 mm
Maximum Anode Cooling Rate	2 kHu/sec
Target Angle	13.5°
Filament Operating Range	4.1 to 12. 2 V 6.0 to 17.4 V
Maximum for Short Period	3.0 to 5.5 A 3.0 to 5.5 A
Maximum Inherent Filtration	1.0 mm of Al

Radiographic Table

Table Weight	403 kg (895 lb)
Table Dimensions	Length: 213 cm (84 in.) Width: 94 cm (37 in.) Height: Variable
Table Capacity	203 kg (450 lb) weight capacity
Table Top Travel	±50 cm (20 in.) longitudinal ±13 cm (5 in.) transverse 26 cm (10 in.) vertical top travel
Rotation	Bucky portrait/landscape pivot 90° Bucky arm rotation ±135° Tower rotation ±180° Base assembly rotation ±180°
Electrical	Input voltage: 110, 230 Vac Input frequency: 50/60 Hz Input power: 1.0 kVA maximum
Room Requirements	Length: 488 cm (192 in.) Width: 488 cm (192 in.) Minimum ceiling height: 282 cm (111 in.) Recommended ceiling height: 290 cm (114 in.) Maximum ceiling height: 300 cm (118 in.)
Door Size	Minimum width: 102 cm (40 in.) Minimum height:198 cm (78 in.)
Floor Strength	2000 psi minimum

Environment

Transit/Storage

Temperature:	-20° to +45°C (-4° to +113°F), assuming the DirectRay Detector is shipped in a Del insulated shipping container
Maximum gradient:	15°C (27°F) per hour, assuming the unit is stored in a shipping container approved by Del.
Relative humidity:	30% to 80% (allow condensation dry time before installing)
Maximum gradient:	10% per hour

Operating

Temperature:	10° to 35°C (50° to 95°F)
Maximum gradient:	5°C (9°F) per hour
Relative humidity:	10% to 80%, non-condensing
Maximum gradient:	10% per hour
Maximum altitude:	3,000 m (10,000 ft)
Maximum vibration:	0.5 G RMS
Pressure:	13.5 to 20.5 psia (700 to 1060 hPa)

Installation Requirements

Flooring

Leveling:	Flat and level within 3 mm (0.12 in.) in both directions over the entire equipment area.
Load–Bearing:	Capable of supporting the operating weight of the equipment. For more information, refer to the specification tables for each subsystem earlier in this appendix.

Ceiling

Suggested Height:	290 cm (114 in.)

Appendix B
Recommended Tools

The following tools and equipment are recommended for installation and/or service of the EPEX/Omniflex IV equipment. Ensure that these items are available and in good condition before beginning any procedures.

Contents

Subject	Page
Hand Tools	B-2
Metric Tools	B-6
Electrical Tools	B-6
Test Equipment	B-7

Hand Tools

The following is a list of the hand tools required:

- Calipers, Precision
- Crowbar
- Grease, Insulating, Silicone
- Hammer, Claw
- Hammer, Rawhide
- Hand Files, Assorted Sizes
- Heat Gun
- Hex Driver Set, T-Handle, Inch
- Hex Driver Set, T-Handle, Metric
- Ice Pick
- Level, Engineer’s, 15-in.
- Level, Spirit
- L-Wrench Set, Balldriver
- Nutdriver Set, Metric
- Pliers, Bent Nose
- Pliers, Channellock
- Pliers, Curved Long Nose
- Pliers, Needle Nose, Electronic
- Screwdriver Set, Offset Ratchet
- Specialized Products Field Service Tool Kit (PN SPC-79)
    - Adapter, DB-25 to DB-9
    - Alignment Tool/Trimpot Adjuster
    - Analyzer, Receptacle, with Ground
    - Blade, Nutdriver, 3/16 to 1/2-in.
    - Blade, Screwdriver, Phillips, No. 0
    - Blade, Screwdriver, Phillips, No. 2
    - Blade, Screwdriver, Phillips, No. 3
    - Blade, Screwdriver, Slot, 1/4-in.
    - Blade, Screwdriver, Slot, 1/8-in.
    - Blade, Screwdriver, Slot, 3/16-in.

- Blade, Screwdriver, Torx, No. T10
- Blade, Screwdriver, Torx, No. T15
- Blade, Screwdriver, Torx, No. T20
- Blade Extension, 4-in.
- Blade Extension, 7-in.
- Cable, Patch, and Coupler, RJ-11
- Cable, Patch, and Coupler, RJ-45
- Cable, Universal, DB-25, 8-ft
- Cable Ties, Assorted, 100
- Crimp Tool, Multi-purpose
- Desoldering Tool, Antistatic
- Extension Cord, All-weather, 10-ft
- Flashlight, Miniature
- Gender Changer, DB-25, Female to Female
- Gender Changer, DB-25, Male to Male
- Hammer, Ball Pein
- Handle, Blade, Regular
- Handle, Tee, Ratcheting
- Hemostat (Seizers), Straight, 5-in.
- Hex Key Set, Inch
- Hex Key Set, Metric
- Knife, Precision
- Measure, Tape, 12-ft
- Mirror, Inspection, with Magnet
- Oiler, Instrument, 2-ounce
- Parts Boxes, Plastic, 2
- Pliers, Cutting, Diagonal, Small, 4-in.
- Pliers, Cutting, Diagonal, Standard, 5-in.
- Pliers, Locking, Vise-Grip, 5-in.
- Pliers, Nose, Chain, Small, 4-in.
- Pliers, Utility, 6-in.
- Pliers, Utility, 10-in.

    - Pliers with Cutter, Long Nose, 6-in.
    - Scale, Metal, 6-in.
    - Scissors, Electrician’s
    - Screwdriver, Phillips, Large, No. 3
    - Screwdriver, Jeweler’s
    - Screwdriver, Pocket, Combination
    - Screwdriver, Reversible, Stubby
    - Screwdriver, Screwholding, Phillips-type
    - Screwdriver, Screwholding, Slot-type
    - Screwdriver, Slot, Large, 5/16-in.
    - Seizers (Hemostat), Straight, 5-in.
    - Solder, Pocket Pak
    - Soldering Iron, Professional, 25-watt
    - Spring Hook Tool, Combination
    - Stripper, Wire, 16 to 26 AWG
    - Stripper, Wire, 22 to 31 AWG
    - Tape, Electrical, 1 Roll
    - Tester, Modem/Telephone
    - Tweezers, Reverse Action
    - Wrench, Adjustable, 4-in.
    - Wrench, Adjustable, 8-in.
    - Wrench Set, Open End, Miniature, 7/32 to 7/16-in.
- Square, Carpenter’s, Steel
- Tap Set, Machine Screw Size
- Wrench Set, Allen, Inch
- Fish Tape
- 6 ft Step Ladder
- Plumb Bob
- Chalk Line
- Torpedo Level
- Lable Making Device

- Wire Labels
  - 10 to 12 Gauge
  - 10 to 16 Gauge
  - 6 to 10 Gauge
  - 10 to 16 Gauge
- Wrench Set Standard And Metric
- Socket Set Standard And Metric
- Soldering Kit
- Digital Volt Meter Lead Set For Dvm
- 50 ft Extension Cord
- Recipricating Saw
- Tap And Die Set
- Level, Bubble
- Level, Framing Square
- Job Box And Casters
- Type H3 Hand Held Vibrating Reed Tach. W/2 Rows 61 Reeds Each
- Hand Drill, Battery Powered
- Phase Checker
- Torque Wrench
- Heavy Duty Work Gloves
- Crowbar
- Lockout Tagout Set Electronic Safety
- Dustpan Hand Sweeper
- Punch Set Center/Drive Pin
- Retaining Ring Pliers, External (2.75 in.)
- Pin Puller/Pusher
- Safety Goggles
- Cable Ties (Zip Ties)
- EPEX Counter Balance Removal Tool
- EPEX Drill Guide (For Table Base)

Metric Tools

The following is a list of the metric tools required:

- Wrench set, combination, 12 pt fractional/ metric, 18 pcs
- Wrench set, 10 pc midget metric combination wrench combo set
- Balldriver set, 1.5 to 10 mm L-wrench, 9 pcs
- Nutdriver set, 4 to 13 mm 10 pcs
- Wrench set, 27 pcs ratchet w/adapter, std and metric
- Socket set, 1/4 driver 10 pcs metric 4 to 13 mm
- Tape measure 30 ft standard and metric
- Gauge feeler
- Kit, field service static dissipative, w/access
- Tap Set
- Wrench Set, Allen
- Wrench Set, Open End

Electrical Tools

The following is a list of the electrical tools required:

- 3/8 in. Cordless Hammer Drill
- 3/8 in. Reversible Cordless Drill
- Hepa Vacuum
- 14 in. Heavy Duty Circular Saw
- Hammer Drill With Cement Anchors

Test Equipment

The following is a list of the test equipment required:

- Antistatic Wrist Strap and Grounding Cord (Sterling Static Protective Field Service Kit [PN 662191-501])
- Cable, Coaxial
- Cable, Triaxial
- Computer, Laptop, DOS-compatible
  - Windows 95 or Windows 98 software
  - Laptop Interface Cable
- Keithley Triad Field Service kit (Keithley PN 10100A)
  - Dosimeter, with kVp and Time Readout
  - Filter Kit, HVL
  - Filter Pack, Wide Range (50 kV to 150 kV)
  - Ion Chamber, 15 cc, with NIST– and/or PTB-traceable Calibration
  - Ion Chamber, 150 cc, with NIST– and/or PTB-traceable Calibration
  - mA/mAs Meter, with RMS Capability
- Light, Strobe, Adjustable Speed
- Oscilloscope, 100 mHz, DSO, such as Tektronix PN THS720
- Phantom
- RMS Meter, Fluke 76 or Fluke 87
- Stand, Test, Quick-set
- Stem, Cable
- Tachometer, Reed

Appendix C
Forms

This appendix provides the required forms for the installation, calibration, and preventive maintenance of the EPEX/Omniflex IV System.

Contents

Subject	Page
System Installation	C-3
System Calibration Forms	C-9
Preventive Maintenance Forms	C-23

System Installation

On the following page is the form required when installing the system using the procedures in Chapter 3.

EPEX Omniflex System Installation Checklist

- ❑ Delivery Completed
- ❑ Equipment Unpacked
- ❑ Return the Detector Array TempTale®
- ❑ Positioning the Equipment
- ❑ Operator Console Installation:
  - ❑ UPS Charged and Grounded
  - ❑ CPU Connected
  - ❑ Array Controller
  - ❑ WAMI
  - ❑ Monitor, Cabled for DRAC and Operator Console CPU
  - ❑ Keyboard, Pointing Device, Barcode Reader
  - ❑ Modem
  - ❑ Serial Extension Bar
  - ❑ Remove Casters
  - ❑ Seismic Anchoring (if applicable)
- ❑ X-ray System Installation:
  - ❑ Position Generator
  - ❑ Verify Line Voltage
  - ❑ Configure Generator Mains
  - ❑ Check Secure Board Seating
  - ❑ Verify Internal Connections
  - ❑ Install High Voltage Transformer Assembly (outside U.S. only)
  - ❑ Seismic Anchoring (if applicable)
- ❑ Rails and OTC Installation
  - ❑ Install the Longitudinal Rails
  - ❑ Install the Lateral Rails
  - ❑ Install the Brakes
  - ❑ Install the OTC
  - ❑ Install the X-ray Tube
  - ❑ Install the Collimator
  - ❑ Cable Drapes
- ❑ Installing the Table
  - ❑ Place the table
  - ❑ Drill the Holes
  - ❑ Secure the Table
  - ❑ Assemble the Tower
  - ❑ Install the Detector Array
  - ❑ Cable to the Generator
- ❑ Electrical and Communication Lines:
  - ❑ Power Source to Generator
  - ❑ X-ray Room Warning Light
  - ❑ X-ray Room Door Interlock
  - ❑ X-ray Tube Anode and Cathode Cables
  - ❑ Operator Console Communication Connections
- ❑ Verify Alignment
- ❑ System Calibration
- ❑ Establish X-ray Light Field Coverage
- ❑ Network Connections
- ❑ Verify Modem Connection
- ❑ System Configuration
- ❑ Application Configuration
- ❑ System Acceptance Testing
- ❑ Return Templates and Caster Bars to Hologic

Initial Volt Measurement

Main Line Fuse Voltage

	Vac
L1 phase to L 2 phase	
L1 phase to L 3 phase	
L 2 phase to L 3 phase	

Driver/Auxiliary Board Voltage

	Vac
F4 to F6	
	Vac
Verify that the voltage is 400 Vac	
Verify there is no voltage present across any main input phases	
Verify that the red LED (Ds1) is lit	

Pass: _____

System Calibration Forms

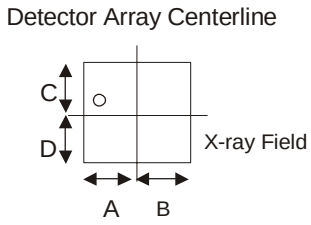
On the following pages are the forms required when calibrating the system using the procedures in Chapter 4.

Testing Calibration

LONG error = (A-B)/2

LAT error = (C-D)/2

Ctr/Ctr error = $\sqrt{[\text{LAT error}]^2 + [\text{LONG error}]^2}$



Indicated size: 25 mm Longitudinal x 20 mm Lateral

Light field size: _____ cm LONG x _____ cm LAT

X-ray field size: _____ cm LONG x _____ cm LAT

Light to X-ray center/center error: _____ mm

Crosshair to X-ray center/center error: _____ cm

Detector Array to X-ray center/center error: _____ cm

Crosshair to Detector Array center/center error: _____ cm

(requirement: error < 2% SID)
(VA requirement: error < 1% SID)

Pass: _____

EPEX Testing Calibration.cdr

AEC Preliminary Overall Gain Calibration

AEC Preliminary Overall Gain

Measured DV for Image Center (ROI) Cell #2 _____

Pass: _____

AEC kVp Compensation for Film Screen 2

kVp	50	55	65	75	85	95	110	120	Delta
Phantom Thickness	1.5 in.	1.5 in.	3 in.	3 in.	4.5 in.	4.5 in.	6 in.	6 in.	N/A
AEC ms									N/A
DV (Mean)									
Reference	6.15	5.78	5.15	4.60	4.10	3.75	2.82	2.18	N/A

(requirement: Delta ≤ 200 to the acquired DV (Mean) at 65 kVp.)

Pass: _____

2nd Iteration
AEC kVp Compensation for Film Screen 2

kVp	50	55	65	75	85	95	110	120	Delta
Phantom Thickness	1.5 in.	1.5 in.	3 in.	3 in.	4.5 in.	4.5 in.	6 in.	6 in.	N/A
AEC ms									N/A
DV (Mean)									
Reference			5.15						N/A

(requirement: Delta ≤ 200 to the acquired DV (Mean) at 65 kVp.)

Pass: _____

Adjusting the Final Ion Chamber Preamplifier Gain

mR	
mR/mAs	
AEC Target mAs	
DV (Mean)	

Pass: _____

EPEX Preamplifier Gain.cdr

Verifying Ion Chamber Preamplifier Balance

Setup:

Grid Speed	medium
kVp	60
mA	25
Phantom	0 in.
Field Size	auto

Balance Data:

	Portrait			Landscape	Portrait/Inverted
AEC Detector(s)	**#1**	**#2**	**#3**	**#5**	**#4**
Detector Selected	**#Lt.**	**#Ctr**	**#Rt.**	**#Rt.**	**#Rt.**
Exposure ms					

Pass: _____

Preventive Maintenance Forms

On the following pages are the forms required when performing system preventive maintenance, including:

- Semi-Annual
- Annual

For preventive maintenance forms for system components, refer to service manuals that came with the system.

Semi-Annual Preventive Maintenance Checklist

Inspection Date: _____ Site: _____

System:

Inspection	Comments
❑ Clean and re-grease all HV connections using vapor proof compound.	
❑ Clean the main cabinet as needed. Refer to the Generator service manual.	
❑ Perform the X-ray tube auto calibration routine. Refer to Chapter 4.	
❑ Verify the calibration of the Generator. Refer to manufacturer's documentation.	
❑ Perform any additional tests required by laws governing this installation.	
❑ Perform a flat field exposure to check image quality.	
❑ Check cables; inspect for cable sheath wear, pinching, or excessive bending.	
❑ Perform mA Calibration.	
❑ Perform DirectRay Controller Calibration.	
❑ Preview image(s).	
❑ Confirm modem is operational.	
❑ Check software/firmware revision levels for equipment. Compare with records (refer to Appendix C); update listing, if required.	
❑ Check logfiles for any unusual error messages.	

Semi-Annual Preventive Maintenance Checklist

System (cont.):

Inspection	Comments
❑ Check for dust in DirectRay Console.	
❑ Check DirectRay Console fan.	
❑ Check all connections and make sure they are secure.	
❑ Check the UPS.	

Annual Preventive Maintenance Checklist

System:

Inspection	Comments
❑ Open the Generator cabinet and examine the unit for any visible damage: missing or loose ground connections, oil leaks, damaged cables, and so on.	
❑ Ensure that there are no obstructions blocking any of the ventilation holes or louvers on the Generator cabinet.	
❑ Inspect ground, handswitch, operator contols, control cables, and strain reliefs for wear and pinching.	
❑ Check U-arm cable drape; inspect for cable sheath wear, pinching, or excessive bending.	
❑ Check sheathing on cables that exit the U-arm and enter the ceiling for pinching, cuts, fraying, or excessive bending.	
❑ Check tightness of all electrical cable connections.	
❑ Check for proper operation of cooling fans; check that blades are clean.	
❑ Check markings on controls and positioner for legibility.	

Appendix D
Field Replaceable Units

This appendix lists the names and part numbers for the most commonly field-replaced EPEX/Omniflex IV System components.

Contents

Subject	Page
Ordering Parts	D-2

Ordering Parts

Parts can be ordered from:

Del Medical Systems
11550 West King Streer
Franklin Park, IL USA
Service: 1-800-800-6006

Component	Part Number	Description	Units per Assembly
DirectRay Console	100-0042	WAMI Power Supply, 12 Vdc	
	295-0675	Reader Barcode Laser	1
	100-0043	Outlet Strip 1.5 meter IEC	1
	180-0439	Cord Power UPS	1
		Cable Power – Modem	1
	180-0440	Cable Power – Power	1
	180-0442	Power Cord Assy (Fans)	1
	180-0443	Cable Assy On/Off Switch W7	1
	180-0444	Cable Assy Prep/Expose Switch W10	1
	180-0445	Cable Serial DB25-DB9 W4	1
	180-0446	Cable Serial DB25-DB9 W5	1
	180-0447	Cable Serial DB25-DB9 W6	1
	180-0448	Cable Serial UPS Data W2	1
	180-0449	Cable Serial W8	1
	180-0450	Cable Serial Splitter	1
	180-0451	Cable Sun 1.2 Meter 50 to 68 Pin SCSI	1
	180-0452	Cable Ethernet Mod Plug UTP Cat 5 Amp	1
	180-0453	Ground Wire Panel	1
	180-0454	Ground Wire UPS W13	1
	465-0044	Switch Generator On White	1
	465-0045	Switch Generator Off Grey	1

Component	Part Number	Description	Units per Assembly
DirectRay Console (cont.)	010-1154	Service Kit (Cable & Keyboard)	1
	180-0459	Cable Video BNC (5) to VGA	1
	330-0013	Fans 110 V	2
	180-0456	Cord Power Supply (UPS)	1
	100-0044	115 V UPS Oneac	1
	120-0180	120 V Modem US Robotics 33kbs 00839-0	1
	120-0196	CPU-Integrated-Unix-Ethernet	1
	120-0190	Adapter Serial	1
	120-0189	Cord Mouse Extension	1
	120-0179	21 in. Monitor	1
DirectRay Console, 230 V	330-0014	Fan 220 V Whisper AC	2
	100-0045	UPS Oneac 230 V	1
DirectRay Controller and DirectRay Detector	010-1253	DRAC, Array Controller	1
	010-1252	Model 100 Medical Grade Array	1
Collimator	590-0528	EEPROM Linear IV	
	590-0529	CPU Board Assembly	
	590-0530	Driver Board Assembly	
	590-0531	Display Board Assembly	
	590-0532	Front Panel Touch Screen	
	590-0533	5 V Logic Switching Pwr Supply	
	590-0538	Linear IV Master Board Assy	
	590-0510	Swivel Mnt Ring Tube	
	590-0511	Swivel Mnt Ring Collimator	
	590-0512	Swivel Ring Collar	
	590-0513	Thumb Screw	
	590-0514	Window Crosshair	
	590-0515	Knob Front Panel	

Component	Part Number	Description	Units per Assembly
Collimator (cont.)	590-0516	Lamp Switch Pushbutton Assy	
	590-0517	Lamp Light Dze 24Vac, 150W	
	590-0518	Socket Lamp	
	590-0519	Current Limit Resistor	
	590-0520	TRIAC 15 A Light Timer	
	590-0521	Prism Centering Line	
	590-0522	Tilt Switch	
	590-0523	Cone Track Kit Option	
	590-0524	Low Filter Mirror Brkt Assy	
	590-0525	Miror/Bracket Assy	
	590-0526	Motor Linear IV Stepper	
	590-0527	Tape Measure	
	590-0534	EMI Filter	
	590-0535	Transformer Pwer27/19 Vac	
	590-0536	Fuse 3A Slo Blo Power	
	590-0537	Fuse 8A Slo Blo Lamp	
	590-0539	Relay 24 VDC	
	590-0540	Potentiometer 1K 10 Turn	
	590-0541	Switch Snap Action	
	590-0542	Cable 70 Inch	
X-ray Tube	480-0034	X-ray Tube Omniflex	
	011-0143	Tube/Trunnion Assy Painted	
	480-0033	PX1436 Dunlee X-ray Tube Unpainted	
	295-0666	Trunnion Ring Assy Unpainted	
Bucky	010-1165	Bucky, DR1000	0
	590-0032	Bucky PCB Assembly	1
	590-0033	Bucky Grid Assembly	1

Component	Part Number	Description	Units per Assembly
Bucky (cont.)	590-0034	Bucky Grid Present Sensor	1
	590-0035	Bucky Fan Assembly	2
	590-0036	Bucky Grid Slide Block W/Harness	1
	590-0037	Bucky Flag, Grid Position	1
	590-0038	Bucky Top Cover Plate	1
	590-0039	Bucky Spring Plunger	1
	590-0040	Bucky Drive Assembly	1
	590-0041	Bucky Vertical Link	1
	590-0042	Bucky Door, Access	1
	590-0043	Bucky Latch, Door (upper/lower)	1
	590-0037	Bucky Flag, Grid Position	1
	590-0038	Bucky Top Cover Plate	1
	590-0039	Bucky Spring Plunger	1
	590-0040	Bucky Drive Assembly	1
	590-0041	Bucky Vertical Link	1
	590-0042	Bucky Door, Access	1
	590-0043	Bucky Latch, Door (upper/lower)	1
	590-0044	Bucky Slide, Linear Bearing	1
	590-0045	Bucky Hinge Pin, Door	1
	590-0046	Bucky Hinge Bushing	1
	590-0047	Bucky Hinge Block	1
	590-0048	Bucky Grid Locating Pin	1
	590-0049	Bucky Home Sensor	1
	590-0050	Bucky Bumper 1 of 2	1
	590-0051	Bucky Bumper 2 of 2	1
	010-1167	Focus Grid, Mid Range	1
	010-1166	Ion Chamber 5 Field W/Pre Amp	1

Component	Part Number	Description	Units per Assembly
CPI	590-0052	Fuse, 60A, 600 V, OTS60	5
	590-0053	Fuse, 2A, 500 V, Time Delay, FNQ2	5
	590-0057	Fuse, 1.6A, 250 V, Slow Acting, GDA1.6	15
	590-0058	Fuse, 2A, 250 V, Slow Acting, GDA2	15
	590-0059	Fuse, 2.5A, 250 V, Slow Acting, GDA2.5	15
	590-0060	Fuse, 5A, 250 V, Slow Acting, GDA5	15
	590-0062	Fuse, 10 A, 700 V, Fast Acting, A70P10-1	5
	590-0086	AEC Board	1
	590-0088	Generator Interface Board	1
	OEM-00008	Dual Speed Starter	1
	OEM-00009	FA, HV O/T	1
	OEM-00010	PWBA, DSS	1
	OEM-00011	PWBA, Generator CPU, 16 Bit	1
	OEM-00012	PWBA, Room I/F	1
	OEM-00013	PWBA, Digital I/O DRC	1
	OEM-00014	PWBA, Auxilliary	1
	OEM-00015	Resonant Assembly	1
	OEM-00016	PWBA, CTL, 80 KW, RF	1
	OEM-00017	PWBA, Inverter, R&F	1
	OEM-00020	PWBA, Filament Supply	1
	OEM-00021	PWBA, P/I	1
	OEM-00022	KIT, DAP, 1T, W/O BRKT	1
Overhead Tube Crane (OTC)	590-0478	Tubestand Controller PS PCB	
	590-0479	Tubestand Controller I/F PCB	
	590-0480	Univ Tubestand Lock Ctrl PCB	
	590-0481	Servo Control PCB	
	590-0482	Interface PCB	

Component	Part Number	Description	Units per Assembly
Overhead Tube Crane (OTC) (cont.)	590-0483	Display PCB with S-9906 S/w	
	590-0484	Display PCB with S-9907 S/w	
	590-0468	CAM Follower, 1/2 Inch Dia	
	590-0469	Limit Switch	
	590-0470	Rotational Potentiometer Assy	
	590-0471	Rotational Potentiometer Cable	
	590-0472	SID Potentiometer Cable Assy	
	590-0473	Vertical Drive Motor	
	590-0474	Chain, 1/4 25# Single Drv Mtr	
	590-0475	Clutch, Brushless DC	
	590-0476	Vertical Drive Mtr Amplifier	
	590-0477	Vertical Drive Mtr Gear Head	
	590-0485	Front Panel	
	590-0486	Switch; All Locks	
	590-0487	Large Magnetic Lock	
Radiographic Table	010-1184	Assembly, Tower Encoder	
	010-1250	Assembly, Detent Solenoid	
	010-1274	Assembly, Arm Rotation Switch	
	010-1297	Assy, Rotary Detent/Latch	
	010-1301	Assembly, Tower Pulley	
	010-1303	Assy, Rot. Detent/Latch, Lower	
	010-1309	Assembly, Detector Switch	
	030-2544	Cover, Tower Top	
	030-2545	Cover, Arm Bearing	
	030-2576	Cover, Tower Pivot	
	030-2578	Cover, Link Middle	
	030-2579	Cover, Inner Pivot, Front	

Component	Part Number	Description	Units per Assembly
Radiographic Table (cont.)	030-2580	Cover, Outer Pivot, Front	
	030-2643	Actuator, Bucky Switch	
	030-2646	Cover, Tower Side, Middle	
	030-2647	Cover, C” Weight Cable, Left	
	030-2648	Cover, C” Weight Cable, Right	
	030-2651	Cover, Tower Vertical Carriage	
	030-2652	Cover, Outer Pivot, Rear	
	030-2656	Cover, Inner Pivot, Rear	
	030-2665	Cover, Tower Side, Top	
	030-2666	Cover, Tower Side, Bottom	
	030-2667	Cover, Cable Bracket	
	030-2668	Cover, Base Carriage	
	030-2669	Cover, Tower Wire	
	030-2670	Cover, Vertical Detent, Right	
	030-2671	Cover, Vertical Detent, Left	
	030-2685	Keypad, Tower Handle	
	030-2686	Keypad, Detector Arm Handle	
	030-2687	Keypad, Detector Handle	
	030-2802	Hose, Tower/Link	
	030-2803	Hose, Tower/Arm	
	030-2816	Cam, Arm Rotation Switch	
	030-2847	Cap, Base Plate Hardware, Blue	
	295-0681	Plug, Hole, Guide Rail Mouting	
	295-0698	Cable, Counterweight	
	295-0674	Table, Radiography	
	295-0231	Assembly, Foot Switch	
	295-0232	Cover, Left Side	

Component	Part Number	Description	Units per Assembly
Radiographic Table (cont.)	295-0233	Cover, Right Side	
	295-0234	Assembly, Cam Follower	
	295-0235	Brake Assembly, Long	
	295-0236	Bearing, Cross-Travel	
	295-0237	Brake Assembly, Short	
	295-0238	Assembly, Thrust Nut	
	295-0239	Cam Follower	
	295-0240	Bearing, Ball	
	295-0241	Assembly, Guide Plate	
	295-0242	Chain, Roller	
	295-0243	Link Chain with Clip	
	295-0244	Fuse, Slow Blow 5 Amp	
	295-0245	Control, Motor	
	295-0246	Power Supply, 24 V	
	295-0247	Sensor, Proximity	
	295-0248	Transformer	
	590-0249	Switch Assembly	
	295-0250	Line Filter	
	295-0251	Motor, 130 V 1/3 HP	
	010-1190	Assembly, Carriage Brake	
	295-0682	Bumper, Rubber	
	140-0107	Assy, Control/Dist PCB, EPEX	
	140-0108	Assy, Port/Land PCB, EPEX	
Interconnect Cables	180-0469	Cable, Horizontal Brakes	
	180-0470	Cable, Link & Tower Rotary Joint	
	180-0471	Cable, Vert Brake Arm/Joint Ex	
	180-0472	Cable, Tower Handle Cable	

Component	Part Number	Description	Units per Assembly
Interconnect Cables (cont.)	180-0473	Cable, Bucky Handle & Arm	
	180-0474	Cable, Bucky Rotation	
	180-0475	Cable, Vert Brks Rotation Joint	
	180-0476	Cable, Car/Arm & Bucky Pos.	
	180-0477	Cable, Panel, Handle Arm-A & B	
	180-0478	Cable, Rotation Sensor & PCBs	
	180-0479	Ion Chamber 36 V PS	
	180-0488	Cable, Position Sensor	
	180-0489	Cable, Bucky Rotation Sensors	
	180-0536	Cable, Array Controller, 85 ft	

Appendix E
EPEX/Omniflex IV System Wiring Diagrams

This appendix includes the schematics for the EPEX/Omniflex IV System.

Glossary

The glossary contains general terms that are used in the service manual.

Accession Number	In DICOM, a term to uniquely identify a visit to a site by a patient. The meaning and use of accession numbers is not consistent in medical information. The DirectRay System uses the DICOM definition of the term.
AEC	Automatic Exposure Control.
Air Gap Technique	A technique that is sometimes used for chest radiography instead of using a grid.
Algorithm	A mathematical method for solving a problem.
Aliasing	Phenomenon of interference that occurs when a signal being sampled contains frequencies that are higher than half the sampling frequency. Typically can be seen as ragged edges on the horizontal lines. According to the Nyquist criterion, the sampling frequency must be at least twice the highest frequency of interest or the highest frequency component in the signal.
Amorphous Selenium (aSe)	Semiconductor material used in the DirectRay Detector to convert X-ray energy directly into electricity.
Amorphous Silicon (aSi)	Semiconductor material found in all TFT arrays.
Analog	Information representation scheme with continuous amplitudes.
Angiography	Radiographic examination of the blood vascular system after the injection of an aqueous solution of contract medium.
Anode	The positively charged portion of a vacuum tube. In the X-ray tube, the anode contains the target that is bombarded by electrons during X-ray production.
Anterior	The front portion of the body, or of an organ or part.
Antiscatter Grid	Device used to prevent the radiation scattered within the patient from reaching the DirectRay Detector and fogging it.
AP	Anterior/Posterior view position for X-ray exposure.
Archive	A computer database for storing images and patient demographic information.
Articulation	The place of junction between two or more bones. Also called a joint.

Artifact(s)	Foreign or artificial marks on a radiograph that may be caused by static, dirty or damaged screens, loose foreign bodies in the cassette, and so on.
Attenuation	The reduction of the intensity of the X-ray beam as it traverses matter by either the absorption or deflection of photons from the beam.
Autoclave	The process of disinfecting articles by heating them with pressurized steam.
Automatic Exposure Control (AEC)	Ion chamber within the Bucky. Used to terminate X-ray when image density is achieved by measuring the amount of dosage occurring at the DirectRay Detector and providing feedback to the X-ray Generator to stop the exposure.
Backscatter Rays	Secondary rays formed when remnant radiation that has passed through the cassette or detector is scattered back toward the image capture mechanism.
Barium	Chalky liquid that outlines various parts of the digestive tract on an X-ray.
Baud Rate	The number of bits per second at which a digital signal is transmitted.
Bit	The smallest unit of information in a notation using the binary system.
Bucky	The component that houses the DirectRay Detector, AEC, moving grid, and related components. In the DirectRay System, the bucky contains the DirectRay Detector instead of the conventional film cassette.
Calibration	Process of measuring the actual output of a machine as compared to its indicated or metered output.
Capacity	General term referring to the maximum output of a machine or to the ability that a device possesses to sustain a load.
Cassette	Device for holding X-ray film during an exposure. It is composed of two fluorescing intensifying screens in a metal and Bakelite holder.
CCD	Charge Coupled Device.
CE Mark	Name of the regulatory clearance needed to ship products to Europe.
Central Ray	Theoretical center of the X-ray beam. The central ray leaves the focal spot at 90° from the long axis of the tube housing. Also known as the principle ray.
Charge Coupled Device (CCD)	A device that converts light into electrical energy. A CCD consists of a two-dimensional matrix of many thousands of individual photosensitive elements. Each element generates a charge that varies with the intensity of the light it receives. These charges are passed out, one by one, row by row, from a single connection to form a continuous analog signal.

Collimator	Regulates the size and shape of the X-ray beam to accurately localize the area of interest on the patient, while reducing overall patient irradiation exposure.
Compton Scattering	Name for almost all of the scatter radiation encountered in diagnostic radiology.
Computed Radiography (CR)	The digital generation of X-ray energy using storage phosphors.
Cone	Cone-shaped device placed between the X-ray tube and the patient to limit the beam of primary radiation striking the part, thus reducing the amount of secondary radiation that is formed.
Contrast Media	An opaque substance used to provide visual contrast in the images of tissues and organs.
CPU	Central Processing Unit of the DirectRay Console.
Crystallography	Experimental technique that exploits the fact that X-rays are diffracted by crystals.
Cycle Time	Total elapsed time from when an X-ray image is captured until another X-ray image can be captured by a digital detector.
Data Compression	A method of reducing required data storage capacity by storing data in encoded form. Various encoding methods are used to eliminate gaps, empty fields, and redundancies to shorten the length of records.
Density	The degree of blackness on a radiograph.
Detail	Relative sharpness of the internal structures of a body as they are demonstrated on a radiograph.
Detective Quantum Efficiency (DQE)	Method for measuring image quality.
Detector Element	Detector element in an image capture device. Sometimes called the Dexel. There are 7.8 million of these in a DirectRay Detector.
Detent	A device for positioning and holding an articulated mechanism in relation to another so that the device can be released by force applied to one of the parts.
Diagnostic X-ray System	An X-ray system designed for irradiation of any part of the human body for the purpose of diagnosis or visualization.
DICOM	Digital Imaging and Communications in Medicine
Digital Imaging and Communications in Medicine (DICOM)	An medical industry standard specification for interconnection of medical imaging equipment.

Digital Signal	A signal whose units are represented by either one of only two states, on or off, yes or no, 1 or 0. Since no gradations in between are permitted, digital signals are precise, unambiguous, and quite immune to noise. Refer to Analog.
Direct Capture	DirectRay technology is a direct conversion process because it directly captures and converts X-ray energy into electrical signals. No intensifying screens, intermediate steps, or additional processes are required to capture and convert the incident X-ray energy. Conventional screen-film, computed radiography, and most emerging flat panel image capture systems are indirect because of their reliance on an X-ray-to-light-to-signal process.
DirectRay (DR)	Registered trademark name for the Direct Radiography Corp. DirectRay Detector and DirectRay Controller.
DirectRay Console	The DirectRay System component that houses the CPU (where the user interface runs), the DirectRay Controller, and the uninterruptible power supply (UPS). It also stores the DirectRay Console Application, the user-interface for the system.
DirectRay Controller	The interface between the DirectRay Detector and the DirectRay Console controls.
DirectRay Detector	The DirectRay Detector is a flat panel that receives the X-ray image and converts it to digital information. The DirectRay Detector replaces conventional X-ray film and cassettes.
Direct Radiography (DR)	A term used to distinguish the use of a photoconductor-based method as opposed to the X-ray capture and conversion method used in a scintillator or phosphor-based detector.
Distortion	Difference in size and/or shape of the radiographic image as compared with that of the part examined.
Dose	Amount of energy deposited in the body tissue because of radiation exposure.
Dosimeter	Device worn for the assessment of dose equivalence.
DQE	Detective Quantum Efficiency.
DR	Direct Radiography/DirectRay.
DRC	DirectRay Console.
DRIVEL	DirectRay Image Viewer.
DROC	DirectRay Operator Console. This abbreviation appears on many of the DirectRay Console application screens and in the Netscape Service Tool.

Dynamic Range	Shades of gray.
Edge Enhancement	Image processing treatment to sharpen the appearance of edges.
EPEX	Del digital radiography system designed to optimize the DirectRay technology.
ESA	Exam Specific Algorithm.
Ethernet	A communications protocol that runs on different types of cable at a data signaling rate of 10 million bits per second.
Exam Specific Algorithm	Algorithm used to optimize raw image data for a particular type of exam.
Fill Factor	As relates to the photon gathering area of the digital detector. For example, 20% of a detector element's area may be used to conduct the charge out of the pixels, thereby making this area insensitive to light. In this example, the detector would only have an 80% fill factor. Due to a mushroom patent, the DirectRay Detector has a very high fill factor.
Filters	Sheets of metal placed in the path of the X-ray to absorb low energy radiation before it reaches the patient.
Filtration	The process of hardening the X-ray beam to increase the ratio of photons useful for imaging to those photons that increase patient dose or decrease image contrast. Inherent filtration is measured in aluminum equivalence, which represents the thickness of aluminum that would produce the same degree of attenuation as the thickness of the material in question.
Flat Plate Detectors	Another name for the new family of digital radiography systems.
Fluorescence	The ability of crystals of certain inorganic salts to emit light when excited by X-rays.
Fluoroscope	Device used to image moving structures with X-rays.
Focal Distance	The distance from the source of the X-rays to the patient.
Frame Grabber	Captures into a computer the analog display output of cameras and VCRs.
Gateway	Devices and conversion method between heterogeneous networks or systems.
General Radiography	Image of skeletal structures in large anatomic areas like the limbs, chest, and the abdomen. Also referred to as Projection Radiography.
Generator	Device that supplies power to and controls the X-ray tube.
Ghosting	Motion artifact in monitor displays of compressed video images.

Goniometer	Device on the Rotating Arm that measures its position.
Grid	Antiscatter Grid.
Grid Ratio	The ratio between the height of the lead strips and the distance between them.
GUI	Graphical User Interface
Hardcopy Images	Printed representations of images or text.
Health Level 7 (HL-7)	Standard that defines the format for interchange of text files between health care databases. A standard interface between Hospital Information Systems (HIS).
Heat Unit	Method for describing the amount of energy produced by and X-ray tube.
High-contrast Resolution	Ability to image small objects having high subject contract and spatial resolution.
HIS	Hospital Information System.
Hospital Information System (HIS)	In a hospital, the computer system that tracks patient demographic information, visit information, and other patient records.
Image Artifact	Non-desirable qualities on a printed image.
Image Intensifier	Used to amplify a fluoroscopic image to reduce patient dose.
Indirect Capture	Image capture systems that involve light in the image capture process.
Integrated/Synchronized	The Operator Console, integrated with the Generator, controls X-ray exposure and image capture.
Intensifying Screen	When X-rays strike these, visible light is emitted.
Intensity	The intensity of the beam is the product of the number and energy of the photons striking a unit of area per unit of time.
Inverse Square Law	The relationship that exists between the intensity of radiation striking the detector and the distance of the detector from the X-ray tube.
Ionization Chambers	The type of phototimer or automatic exposure control device used.
Ionization Ratio	The type of phototimer or automatic exposure control device used with iiRAD products.
Kilovolt	A unit of electromotive force equal to 1000 V.
kVp	Peak kilo-volts. Determines the highest energy of X-rays emitted by an X-ray tube (equal to the peak applied tube voltage). The higher the kVp, the greater the energy or force, the more penetrating power the X-ray has.

Latent Image	Image stored in the silver halide emulsion made manifest by chemical processing.
Lateral	Possible view position for X-ray exposure so that the X-ray beam passes from one side to the other. Pertains to the side away from the midline.
Latitude	Range of X-ray exposure over which a radiograph is acceptable.
LED	Light Emitting Diode.
Leveling	Software manipulation technique that compensates for a monitor's inability to provide the same contract and bit depth as the original hardcopy X-ray.
Longitudinal	Positioning along the patient axis.
Look-Up Table (LUT)	A table of values used to convert raw image data to output data for a specific ESA setting.
Low-contrast Resolution	Ability to image objects with similar subject contrast; image detectability.
LUT	Look-Up Table.
mA	Milliamperes. The quantity of radiation. For example, as you go from 100 mA to 200 mA, you are increasing the quantity of radiation.
Magnetic Disk	Flat circular plate with a surface layer on which data can be stored by magnetic recording.
Matrix	Array of numbers in rows and columns.
mAs	Milliampere-seconds. Combined with kVp, it indicates the dose of X-rays.
Medial	Portion of a structure or part that is nearer to the midline than some reference point. The opposite of lateral.
Millirad	A unit of measuring radiation does equal to one thousandth of a RAD.
Modalities	Image generating equipment, such as CT, MR, and conventional X-ray machines.
Modulation Transfer Function (MTF)	A mathematical procedure for providing an objective measurement of the combined effects of sharpness and resolution. The MTF represents a ratio between the information recorded and the total amount of information available. The MTF is usually calculated from the corresponding line spread function by a complex mathematical operation known as the Fourier transformation.
Moire Pattern	The pattern distinct from its components.

Moving Grid	Grid that moves according to a preset time of exposure, or reciprocates continuously.
Noise	Noise destroys image quality.
Nyquist Frequency	The highest frequency that can be accurately reproduced by the detector.
Oblique	Possible view position for X-ray exposure.
Opaque	Impenetrable by light or X-rays in the diagnostic quality range.
Operating System (OS)	The basic software control system of the CPU.
Overexposure	The result of exposing an X-ray image or person to an excessive amount of X-rays.
PA	Posterior/Anterior view position for X-ray exposure.
PACS	Picture Archiving and Communications System.
Peak kilo-volts (kVp)	An electrical term used in setting X-ray exposures.
Penetration	The ability of X-rays to pass through the material.
Photons	Discrete bundles of energy that travel at the speed of light.
Photostimulation	Emission of visible light following excitation by laster light.
Picture Archiving and Communications System (PACS)	The Picture Archiving and Communications System is a set of software applications that enables hospital network users to enter, review, and print patient demographic and radiographic study information. It contains archive and workstation hardware, and requires a network connection.
Pitch	Measurement of the detector elements from center-to-center.
Pixel	The fundamental picture element of a digital image.
Portrait Position	The long dimension, parallel to the patient axis.
Posterior	Toward the back (or dorsal area) of the body.
Projection Radiography	Refer to General Radiography.
Procedure	A predefined collection of images (views) for X-ray exposure.
Prone	A position of the body lying face down.
Proximal	Nearer the point of attachment or origin.
Quality	Refers to the energy of the photons.
Quantity	The number of photons in the beam.
RAD	Radiation Absorbed Dose.

RADEX	Del digital radiography system designed to optimize the DirectRay technology.
Radiation Absorbed Dose (RAD)	A unit that measures radiation in terms of the absorbed dose. For radiologic procedures it is equivalent to the REM.
Radiation Oncology	A branch of radiology that deals with the therapeutic applications of radiant energy.
Radiation Therapy	Large doses of radiation are used to treat cancer by killing cancer cells. This treatment is **not** usually part of a radiology department, and treatment is given by physicians who are specialized in this field (radiation oncologists).
Radiography and Fluoroscopy (R/F)	X-ray system that shows the workings of the gastrointestinal (GI) tract. Diseases and abnormalities of the GI tract such as cancers, ulcers, tumors, and obstructions can be diagnosed with R/F imaging.
Radiological Society of North America (RSNA)	Largest scientific society of radiologist and medical physicists.
Radiology Information System (RIS)	In a hospital, the computer system that tracks patient demographic information, visit information, and other patient records.
Radiopaque	Tissue or material that absorbs X-rays and appears bright on a radiograph.
Radiopharmaceuticals	Basic radioactively tagged compound necessary to produce a nuclear medicine image (also referred to as tracer).
RAM	Random Access Memory.
Rare Earth Materials	Phosphors are identified in the periodic table of elements as rare earth elements because they are rare in the earth’s atmosphere. They are very close to each other and difficult to separate. Refer to intensifying screens.
Recumbent	Lying down or reclining.
REM	Roentgen Equivalent Man.
Resolution	Ability to image objects with fidelity.
Resolving Power	Ability of an imaging system to record separate images of small objects that are placed very close together. The resolving power of an imaging system is usually measured with a series of parallel wires or lead strips, placed so that the space between each strip is equal to the width of a strip. The resolving power of the system is usually determined by how many line pairs per mm can be clearly seen in the developed radiograph.
RIS	Radiology Information System.

RISC	Reduced Instruction Set Computer.
Roentgen	The unit of radiographic exposure dose designed by the symbol R. One R of exposure will produce in tissue an absorbed dose of approximately one rad. Named after Wilhelm Conrad Roentgen, the scientist that discovered X-rays in 1895.
Roentgen Equivalent Man (REM)	A unit that measures radiation in terms of the energy involved (the same as RAD), weighted by a factor related to the type of radiation. For the types of radiation used in radiologic procedures this factor is equal to one, so the REM is equivalent to the RAD.
RSNA	Radiological Society of North America.
Scan	Term used to describe the computerized images (pictures) generated by CT, MRI, ultrasound, and nuclear medicine studies. These might be referred to as a CT scan, MR scan, thyroid scan, bone scan, and so on.
SCR	Silicon Controlled Relay.
SCSI	Small Computer System Interface.
Secondary Factors	Factors that describe the quality of a finished radiograph – density, contrast, detail, and distortion.
Sharpness	The ability of the imaging system to record sharply defined margins, or abrupt edges. An unsharp edge may be easily seen if contrast is high, but a sharp edge may be poorly visible if contrast is low.
Shonin	Name of the clearance needed to sell in Japan.
SID	Source to Image Distance.
Signal-to-Noise Ratio (S/N Ratio)	The ratio of the peak amplitude of the signal to the rms value of the noise.
Softcopy	The image output when displayed on monitors or workstations.
Soft Tissue	Radiographic technique that demonstrates anatomical details of soft tissue.
Solaris	Sun Microsystems' commercial version of the UNIX operating system.
Source to Image Distance (SID)	The distance from the source of the X-rays to the detector.
Spatial Resolution	Property of distinguishing two equal sized adjacent objects in the same place. Refers to the number of pixels in a specified area.

Staging Area	The area where the Del representative unpacks and assembles the components of the system.
Sterotactic	Technique of viewing objects from two slightly different angles to give a perception of depth.
Study	A specific instance of a procedure consisting of a set of X-ray images.
Supine	Lying face up.
Technique	A technique is a combination of X-ray parameters (kVp, mA, time) that are defined for a particular procedure.
Technique Factor	Any of the parameters describing the properties of an X-ray beam, including beam energy (kVp), beam intensity (mA), exposure (mAs), duration (seconds), and, at times, the Source to Image Distance (SID).
Technologist	Person trained in the technique of producing an X-ray image.
TFT	Thin-Film Transistor.
Thoracic	Pertaining to the region of the chest.
Three-phase Generators	A three-phase Generator produces an almost constant voltage because there are no deep valleys between pulses. Commercial electric power is usually produced and delivered by three-phase alternating-current (ac) Generators.
Tiling	Process of putting two TFT arrays together.
Tomography	Method of producing a 3-D image of internal objects by comparing the X-rays that are absorbed at various angles.
Trabecular Detail	Any of the small strand of connective tissue projecting into an organ and constituting part of the framework of that organ.
Transformer	Device that either increases or decreases the voltage in a circuit.
Transmission Window	The active area of the Detector Array that is projected to the outer surface of the unit.
Transverse	Crosswise. Lying perpendicular to the longitudinal axis of the body.
Underexposure	The result of exposing the X-ray device to an insufficient amount of X-rays.
Uninterruptible Power Supply (UPS)	Especially equipped power supply that uses a battery backup to make sure there is continuous, steady power in the line regardless of voltage drops or a total loss of standard power.
UPS	Uninterruptible Power Supply.

View	Prescription for the technique factors and geometric arrangement of the X-ray source, patient, and image sensor that yields and image of organs of interest seen on a specific orientation.
Visit	A set of studies identified in a locally unique manner and performed on a particular patient at a particular site for a particular reason. A visit is normally identified by an accession number or a Visit ID and is associated with a diagnosis.
Windowing	Software manipulation that compensates for a monitor's inability to provide the same contrast and bit depth as the original hardcopy X-ray.
Wiring Adaptable Machine Interface (WAMI)	The Operator Console interface connection to all the other system components.
X-ray Film Speed Class	The measured speed of a screen-film system depends on a number of variables such as the kVp, amount of scatter radiation, X-ray absorption by the cassette, or X-ray table top, and the way the film is processed.